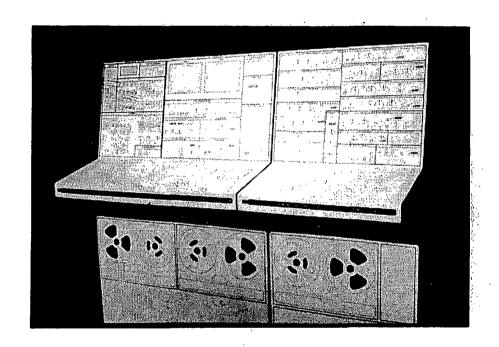
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# DEVELOPMENT OF FLIGHT EXPERIMENT WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

### FINAL REPORT CONTRACT NAS8-28359

**AUGUST 31, 1973** 



PART I

CASE FILE COPY





September 14, 1973

MTX: 73/626

Mr. Arthur W. Galzerano (S&E-S/P-T) National Aeronautics and Space Administration Marshall Space Flight Center, Alabama 35812

Subject: Contract No. NAS8-28359, "Development of Flight Experiment Work Performance and Workstation Interface Requirements"; Transmittal of Final Report

Dear Mr. Galzerano:

In accordance with the requirements of the subject contract, as amended by Supplemental Agreement No. 3, the approved Final Report is herewith submitted. Distribution of the report is indicated on the attached distribution list.

Sincerely,

G. Richard Hatterick Project Director

GRH:fs

PRL: 415

cc: Letter Only

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### WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

**CONTRACT NAS8-28359** 

FINAL REPORT - PART I

TECHNICAL REPORT
AND
APPENDICES A - G

**AUGUST 31, 1973** 

### PREPARED FOR:

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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### ACKNOWLEDGEMENTS

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Project Director for the URS/Matrix Company was G. Richard Hatterick. Principal contributors from the URS/Matrix Company, Man Systems Division, to the performance of the study reported herein were Robert C. Harrison, Edwin C. Pruett, James H. LeFan, Benita C. Hayes, Estelle M. Wald, and Thomas A. Dashner.



### FOREWORD

This study contract (NAS8-28359) was awarded to the URS/Matrix Company by the NASA George C. Marshall Space Flight Center to define the task performance capability requirements and to develop concepts for the experimenter workstations for selected early Shuttle Sortie missions. A further goal was to update and expand the task performance requirement/capability data base. Methodology utilized in defining task performance requirements and requisite skills for payload experiments was the "Task-Skill" technique developed under Contract NASW-2192.

Readers of this report who are closely associated with the Sortie Lab program will recognize instances where statements made, or data presented, herein are not in accord with their own knowledge of the program. Every resonable attempt has been made to incorporate or reflect the current status of Sortie Lab definition and development. Such discrepancies are more easily understood when it is recognized that this study was initiated during the transition from the earlier baseline of "Blue Book" data, subsequently modified by RAM and SOAR studies, to what is now known as Sortie Lab. The rapidly changing environment in which experiment and payload definition studies are conducted makes such discrepancies inevitable.

This report provides a brief description of methodology, a presentation and discussion of the skill requirements for early Sortie Lab Earth Observation and Materials Sciences payloads, and the results of the analyses to define concepts for experimenter workstation configurations for these missions. It is expected that this report will have greatest utility to those involved in training and personnel resource planning, and Sortie Lab Support Module designers. It should also be useful to mission planners confronted with problems regarding payload composition.

The report is packaged in two parts:

Part I: Technical Report, with Appendices A - G containing explanatory data.

Part II: Appendix H, containing the Data Sheets resulting from the Task/Skill Requirements Analysis.



### SUMMARY

Preliminary NASA studies aimed at definition of experiments and payloads for orbiting with the Space Shuttle system have included various types of crew skill requirements identification. The skill identification methods used, however, were inadequate, especially when applied to relatively undefined systems and configurations.

This study applied a skill requirement definition method (originally developed under Contract NASw-2192) to the problem of determining, at an early stage in system/mission definition, the skills required of on-orbit crew personnel whose activities will be related to the conduct or support of earth-orbital research. The experiment data base was selected from proposed experiments in NASA's Earth Orbital Research and Application Investigation program as related to Space Shuttle missions, specifically those being considered for Sortie Lab.

Activities during the study, documented in this report, include identification of basic functions dealing with man's research and/or servicing activities on orbit. A Crew Function Taxonomy was prepared relative to these activities. Likely candidate experiments for Shuttle Sortie missions were selected through extensive review of experiment and mission descriptions.

Crew functions and tasks were initially identified for more than fifty representative earth orbital experiments, and a comprehensive task analysis was conducted on these tasks for selected payloads.

Crew skill requirements for performance of three Earth Observations experiments and eight Materials Sciences experiments were identified through a technique called Task-Skill Requirements Identification. The concept and procedure of this technique, including use of the Task Dependency Reference system, is discussed, along with conversion of Task-Skills to Occupational Skill Classifications.

In addition, concepts for two integrated workstation consoles for Sortie Lab experiment operations were developed, one each for Earth Observations and Materials Sciences payloads, utilizing a common supporting subsystems core console.

A comprehensive data base of crew functions, operating environments, task dependencies, task-skills and occupational skills applicable to a representative cross section of earth orbital research experiments is presented. All data has been coded alphanumerically to permit efficient, low cost exercise and application of the data through automatic data processing in the future.



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## DEVELOPMENT OF FLIGHT EXPERIMENT WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

CONTRACT NAS8-28359

FINAL REPORT

**SECTION 1.0** 

INTRODUCTION





### SECTION 1.0

### INTRODUCTION

### 1.1 SCOPE AND OBJECTIVES

The contract under which the study reported herein was conducted (NAS8-28359) had three primary objectives: (1) to establish the scientific and technical task performance capabilities required for selected early Shuttle-Sortie missions; (2) to define experimenter interface concepts for two selected Sortie Lab experimenter workstations; and (3) to expand and update the existing experimenter task requirements data base. Input data to be used in achieving these objectives were the most current descriptions of experiments and missions available (including the "Blue Book", results of the RAM Phase B studies, and ongoing MSFC Sortie Lab preliminary definition studies), and the methodology developed and demonstrated by URS/Matrix under Contract NASw-2192, Development of Flight Experiment Task Requirements.

### 1.2 BACKGROUND

### 1.2.1 Early Man-in-Space

NASA's manned space flight programs during the 1960s were primarily aimed at qualifying man and machine systems for space flight and lunar exploration. In the 1970s, emphasis has changed toward utilization of manned space flight to perform research and technology experimentation in earth orbit, beyond the restrictions and constraints of the earth's atmosphere. Several such experiments were conducted in the Apollo Program, subsidiary to the primary mission of lunar exploration. The Skylab Project has gone further with experiments such as the Apollo Telescope Mount (ATM) studies of the sun, and Earth Resources studies of the surface of the earth. The primary purpose of Skylab, however, is to study the ability of man to perform effectively in space for long durations. Each of these programs, from Project Mercury through Skylab, will have added valuable knowledge about man in space, his spacecraft, the tools he needs in space, and the space environment. All of the crewmen on these missions will have been highly trained and dedicated astronauts, many having been military aircraft test pilots and some having commendable scientific credentials as well. Recent completion of the Skylab 1/2 Mission has given new evidence that man can not only perform effectively for long durations in space but also that in-space research may be severely constrained without his immediate presence.

### 1.2.2 Automated Research

For a number of years, automatic satellites have been gathering data on the earth-proximal space environment and making observations of the earth's surface and atmosphere from earth orbit, in addition to their use in planetary exploration. Valuable as these investigations are, they are technologically



expensive to prepare, difficult to control, and relatively inflexible in their application. Automatic satellites will undoubtedly continue to be aptly utilized for dedicated research and applications missions and/or where the environment is too hazardous for man in space. Notwithstanding the continued utilization of automatic satellites, however, it is evident that the future of in-space research will depend on extensive application of man's versatility and knowledge directly at the site of the research, i.e., in orbit.

### 1.2.3 Space Shuttle/Earth Orbital Research

With the Space Shuttle (now in early development and expected to be available about 1980), the United States will have the capability of placing experiment payloads in earth orbit for observation of the earth's surface, conduct of experiments and investigations regarding the space environment, or research into scientific and technological areas which capitalize on the unique characteristics of the orbital space flight environment. These experiment payloads will vary in content and purpose from small, self-contained orbital laboratories in the Shuttle cargo bay, to orbiting automated research satellites, to eventual experiment modules for a permanent orbiting Space Station. Preliminary definition studies are being conducted to identify the characteristics of the candidate experiments and the ways in which they may be grouped and/or combined into Shuttle mission payloads. Emphasis at present is being placed on the "Sortie Lab" concept, wherein experiment payloads will be housed in a special module or on a pallet carried in the cargo bay of the Shuttle Orbiter. Initial flight durations will encompass periods up to seven days; later missions may extend to thirty days or possibly longer.

### 1.2.4 Development of Flight Experiment Task Requirements (NASw-2192)

Just as the nature of the missions being planned has changed, the duties of the experiment personnel will be very different from those of the pre-Skylab crewmen. These duties will involve setup and maintenance of sophisticated experiment equipment, decision making and control functions regarding the conduct of experiments, and, in many instances, the interpretation of collected data. Pre-Phase A studies of experiment requirements have recognized these changes by identifying and categorizing Functional Program Elements (FPEs)\* and experiments by the "skill" areas thought to be reflective of the primary purpose of the experiment and the professional discipline or occupation involved. The methods utilized to identify these skill areas were inadequate, however, when applied to relatively undefined systems and configurations. A need was recognized for a valid, flexible skill identification technique which could be

<sup>\*</sup>The term "Functional Program Element" (FPE) describes a gross grouping of experiments which are each mutually supportive of a particular area of research or investigation and which impose similar or related demands on the orbiting research facility.



applied during the early stages of system definition.

In support of the new role for man-in-space, a study was performed under Contract NASw-2192 to develop the means to identify the task performance requirements of the experiment module scientific and technical crews for the conduct of the planned types of orbital experimentation. That study, based on a sampling of representative experiments, confirmed the wide variety of skills which will be needed by the crew to work successfully with the projected experiment payloads. In the conduct of the study, the URS/Matrix Company Man Systems Division successfully developed and demonstrated a technique for skill identification which is not dependent on traditional occupational titles with their inherent and frequently misleading connotations of expertise in technical and scientific areas. Rather, the technique permits identification of specific task performance requirements based on the purposes and objectives of either general or specific tasks and subtasks and the interfaces with certain items of equipment, facilities, and environmental factors. While avoiding the occupational implications during the analytical phase of determining task performance capabilities, the method retains compatibility with occupational and professional designations. This feature simplifies the early identification of candidate personnel with the most nearly correct combination of task performance capabilities. Alternatively, the skills of selected experiment crew members can be compared to skills required for a particular mission to identify specialized training which may be required. The full report of this study, published in June 1972, is included in the bibliography of this report, as References 67, 68 and 69.

### 1.3 DEVELOPMENT OF FLIGHT EXPERIMENT WORK PERFORMANCE AND WORKSTATIONS INTERFACE REQUIREMENTS (NAS8-28359)

Apace with the definition of experiments and systems for manned research in space, and the availability of a technique for making valid assessments of requisite crew requirements and interfaces, the current study was initiated under contract to NASA's Marshall Space Flight Center. It was recognized that in order to provide for early identification of candidate experiment scientific and technical personnel, a systematic, in-depth analysis of the requirements for scientific and technical task performance capabilities was needed, together with identification of workstation interfaces upon which these skilled experimenters would be dependent. From such identifications, performance capability requirements and criteria for flight experiment crew complements and workstation concepts capable of accommodating a wide variety of flight experiments in many different combinations could be developed.

The approach used to accomplish this task is discussed in Section 2.0 of this report. Results achieved in the identification of performance capability requirements and the definition of preliminary workstation concepts are presented and discussed in Sections 3.0 and 4.0, respectively. Section 5.0 summarizes the findings of the study, together with relevant conclusions



regarding their application to other current and planned man-in-space development efforts. In addition, recommendations are presented for follow-on efforts to make maximum and timely utilization of the data developed thus far. Explanatory and reference data are presented in Appendices A through G of this volume; Task/Skill Requirements data sheets for the experiments/payloads subjected to analysis in this study are included in Appendix H, a separate volume of this report.

### WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

CONTRACT NAS8-28359

FINAL REPORT

SECTION 2.0
TECHNICAL APPROACH





### SECTION 2.0

### TECHNICAL APPROACH

This section of the final report presents a discussion of the approach used by URS/Matrix to achieve the objectives listed in Section 1.0, and a brief description of the method for identification of scientific and technical crew performance capability requirements.

### 2.1 STUDY APPROACH

### 2.1.1 Assumptions, Guidelines and Constraints

The major guidelines underlying the URS/Matrix program of study were as follows:

- (1) Task requirements were to be determined only for experiment-related tasks, specifically excluding such functions as were required for operation and/or maintenance of the Shuttle Booster and/or Orbiter.
- (2) Performance requirements and capabilities were to be identified for nominal modes of operation only, with no special attention to contingency or emergency modes.
- (3) Experiments/payloads to be subjected to analysis were to be selected from those defined for Shuttle-Sortie missions in the Research and Application Module (RAM) Programmatic Reference Experiment Plan (REP) in the RAM Phase B Study (Ref. 37). Subsequent to initiation of the study, it was mutually agreed between URS/Matrix and NASA representatives that the selected experiments should correlate as closely as possible with those being identified for early (1979-1982) Sortie Lab missions (Refs. 48, 49, 92, 93, 112, 119).

### 2.1.2 Study Plan Summary

The study plan followed by URS/Matrix emphasized maximum utilization of data from recent and ongoing experiment definition studies, as well as the preliminary task analysis conducted under a prior contract (Ref. 69). The general flow of the study is illustrated in Figure 2-1. The study was initiated by an in-depth review of available data (see Appendix A) in support of the NASA Reference Experiment Plan (REP) and the emerging Sortie Lab definition. The initial output of this effort, depicting RAM-identified payloads and missions which were potentially feasible for study, and their status relative to the existing task-skill data base, is shown in Figure 2-2. Figure 2-3 shows the results of the initial screening on the basis of the "early mission" constraint. It should also be noted that two "man-tended" payloads (i.e., free-flyers) were being considered for study in addition to Shuttle Sortie payloads. On the basis of this screening, the payloads/experiments listed in Figure 2-4 were selected for the first step of the task requirements



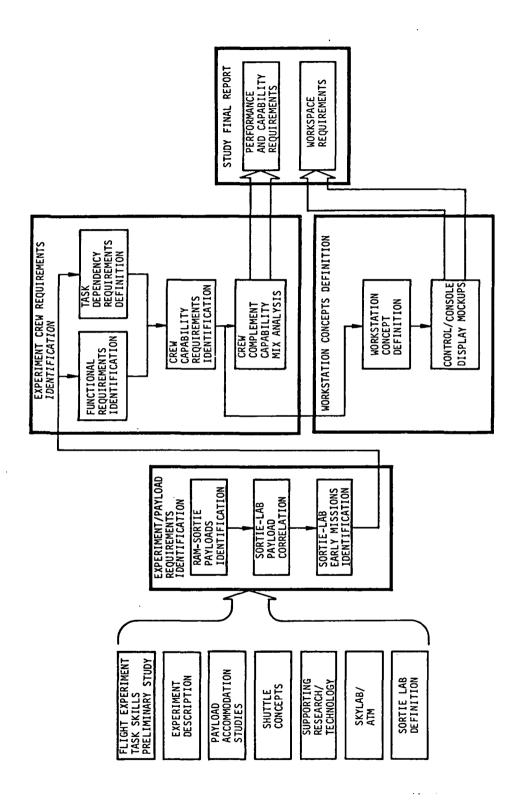


Figure 2-1: Project/Task Flows, NAS8-28359



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Figure 2-2: RAM Phase B REP Payloads Correlated to NASw-2192 Analyses

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TBloresearch Module - Flies piggyback on applicable sortie payloads on resources - available basis at rate of 2 times/yr for the first 3 years. Two experiment modules may be delivered on same flight.

\* A502D, A202B are alternates for A503B and A203B respectively.

\*Operational payloads for these FPEs not included on REP.

Payloads excluded from study.

Figure 2-3: Identification of Early Missions Per RAM Programmatic REP.



identification -- the Crew Function Analysis (Correlation with Sortie Lab payloads had not yet been achieved).

With the availability of the initial definition of projected Sortie Lab payloads (Refs. 49, 112), a correlation was made between Sortie Lab payloads and those identified in RAM and Shuttle documentation as early Shuttle missions. This correlation is shown on the lower portion of Figure 2-4.

For purposes of this study, the most feasible Sortie Lab payloads to be subjected to detailed task and skills analysis were those in Earth Observations (EO), Materials Sciences and Manufacturing (MS), and Space Physics (SP). A determination was made to select the following Sortie Lab payloads for completion of the study.

### Earth Observations

EO-3 Air and Water Pollution

E0-4 Resource Recognition

EO-5 Disaster Assessment

### Materials Sciences and Manufacturing

MS-1 Biological Experiments

MS-2 Levitation Experiments

MS-3 Furnace Experiments

MS-4 Small and Low Temperature Experiments

Using this list of reference payloads/experiments, the detailed analysis of task dependencies and skills proceeded, following the methods described in Section 2.2. As the interfaces between the scientific/technical crew members and their equipment/instrumentation were defined, concepts for the Earth Observations payload and the Materials Sciences payload control/display workstations were developed.

Results of the task/skill analysis and the workstation concept development portions of this study are presented in Sections 3.0 and 4.0 respectively.

### 2.2 TASK/SKILL IDENTIFICATION METHODOLOGY

The methodology used in this portion of the study was that which was developed and demonstrated under Contract NASW-2192, and which is fully described in that study's Final Report (Ref. 68). The description which follows covers only the basics, to provide potential users of the data contained in subsequent sections with sufficient understanding to permit application of the data to their particular problems.

### 2.2.1 Origin and Rationale of Task-Skill Methodology

Reports prepared in support of NASA's earth orbital research and applications programs had included listings of "crew skills" for the various experiment areas. Of primary importance in this respect was the NASA "Blue Book" (NHB 7150.1) (Refs. 1 through 8), which listed twenty-seven (27) crew skills required



	Т			DISC	ASTRONOMY			COMM/NAV	EARTH OBS			LIFE SCIENCES		MATERIALS SCIENCES 8 MANUFACTURING		PHYSICS		TECHNOLOGY	
1 1				FPE	A-2 <sup>+</sup>	A-3 A-5	A-6 <sup>+</sup>	C/N-1	ES-1	LS-3 LS-4	LS-5	LS-6	LS-7	MS MANUFACTURING	P-1	P-2	P-3 P-4	#	T-2 T-5
								x x x x	ххх			X X		* * * * * * * * * * * * * * * * * * * *	x x <del>x</del> x x x x x		ххх		хх
MISSION ACCOMMODATION MODE	DISCIPLINE		SHUTTLE PAYLOAD (PER RAM PHASE B PROGRAMMATIC REP)	EXPERIMENT TITLE	Extended Sources Observations Nebulae and Galactic Studies Narrow Field Imaging and Photometry Narrow Band Imaging and Photometry Hign Speed Spectral Studies Echelle Spectrometry Intermediate Spectrometry Middle IR Spectrometry Middle IR Spectrometry Polarimetry - Wollaston Polarimetry - Reflection	Photoneliograph Experiments (65CM) Low Energy X-Ray Telescope Experiments Narrowband Spectrometry/Polarimetry	Hi Resolution Gamma Ray Spectrometry IR Radiometry (ARC) IR Spectrometry (ARC)	Optical Frequency Demonstration Millimeter Wave Comm Sys and Propagation Demon Surveillance Search Rescue Sys Demonstration Satellite Navioation Tecn for Terrestrial Users	Air and Water Pollution Resource Location and Identification Disaster Assessment	Metabolism and Energetics in Hypogravity Responses of Plant to Hypogravity-Gradient Low -G Effects on Tradescantia Effect of Weigntlessness on Small Organisms Effect of Weigntlessness on Human Chromosomes	Effect of Heightlessness on Plant Tumor Inssues Vinegar Gnats in Space Circadian Periodicity of Cockroach Activity Emmined Snare and Irradiation Effects	Water Recovery Hethods and Components Waste Management Methods and Components Advanced Cooling System Methods and Components Zero-Gravity Minole-Boody Shower Advanced Two-Gas Atmosphere Supply Subsystem Acmosphere Supply Hethods and Components Carbon Dioxide Collection Methods and Components Advanced Trace-Contaminant Subsystem Advanced Space Suit Assemblies Eff Suit and Biopack Fond Kthozen, Preparation and Feeding Methods	Sensory Processes in Spaceflight Environment Cognitive Processes in Spaceflight Environment Psychomotor Function in Spaceflight Environment Individual and Group Dynamics in Spaceflight Cargo Handling Capabilities Assembly, Deployment, Maint. and Repair Capab Locomotion and Restraint Capabilities System Controller Capabilities Interior Configuration, Environment and Decor Off-Duty Activities and Facilities Sill Retention and Assessment Locomotion and Balancing in Rotogravitation Fine Psychomotor Capabilities in Rotogravity Gross Psychomotor Capabilities in Rotogravity	Composites Contr. Density Mts. Free Casting Liquid Dispersions Cryst. Growth/Melt Cryst. Growth/Walor Supercolg/Nucleatn. Preparatto. of Glasses Biolog. Separation Phys. Proc. in Fluids	Optical Sensing of Auroras Optical Aeronomic Measurement Particle Heasurements Incl Energy + Angular Dis Arbient Environment Heasurements VIF Sensor Measurements Cometary Physics/Gaseous Release of NH <sub>3</sub> and ICN Prelim. Astronomical Spectrometry	Mear Wake Region Measurements (Vehicle Surface) Boom Mounted Sensor Measurements Plasma Resonances Measurement Plasma Resonances (Measurement From Subsatellite Harmonic Resonances + Transmission Delay Investig, of Wave/Particle Interaction by VLF Electron and Ion Beam Measurements From RAM	2	Sky Background Brightness Measurements Real Time Contamination Measurements Surface Degradation Experiment Contamination Cloud Composition Measurements IRTOM Optical Module Evaluation Active Cleaning Technique Evaluation Contamination Control Evaluation	Evaluation of Propellant Transfer Methods Teleoperation Initial Flight Exper. Teleoperation Functional Manipulator Expr.
		P/L CODE	PAYLOAD TITLE	GDC Ist FLT	22310 22320 22330 22330 22350 22370 22370 22382 22332 22333	25100 25100 25300	25600 26500 26600	51010 51020 51030 51040	41300 41400 41500	83001 83002 83003 84001 84002	85001 85001 85002 85003	86003 86004 86004 86005 86005 86009 86009 86010	87001 87003 87004 87005 87005 87006 87000 87011 87012 87013	61001 61002 61003 61004 61005 61005 61008 61013	31131 31132 31150 31170 31180 31200 31410	32110 32115 32210 32210 32215 32220 32300	33500 34001 34002	71001 71002 71003 71004 71005 71006 71007	72020 75001 75002
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		CISÍF C	ommunication/Navigation - Lab I (Austere) ommunication/Navigation - Lab I (Austere)	1981 1982				• • •	_										
	088		arth Observation - Air & Water Pollution Austere)	1981					•									j	
SORTIE MISSIONS	IRTH	EISIQ E ( EISIR E	arth Observation – Resource Location Austere) arth Observation – Disaster Assessment Austere)	1980 1982					•										
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SHUTTLE	SCIENCES	MISIE M	IS Configuration #1 - Operations Level #1	1980										• • • • • • • •					
	SICS	P5S2A C P7S1A C	ombined Space/Plasma Physics (Austere) ombined Space/Plasma Physics (Intermediate) ombined Cosmic Ray Physics & Chemistry Austere)	1980 1982 1982								÷			•••••	• • • • •			
	S 1	TIS3A Co	momplete Contamination Measurements ropellant Transfer Exp't. leoperator Exp't.	1979 1980 1982														• • • • • • •	• • •
SHUTTLE SUPPORTED FREE-FLYER MISSIONS	ASTRONOMY	A202B L. A502D н	arge Space Telescope (LST) igh Energy Stellar Astronomy Observatory	1981 1979	• • • • • • • •		•												
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		С	OMM/NAV					C1				:							
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co	SORTIE LAB PAYLOAD RRELATI TO RAM	ION L	IFE SCIENCES									No Correlation Could Be Established	1						
		,	NATERIALS SCIENCES											8.5.5.2.4.4.4.5.5.5.5.5.5.5.5.5.5.5.5.5.5					
		F	PHYSICŞ	-											SP-1 SP-1 SP-2 SP-4 SP-4	SP-5 SP-5 SP-7 SP-7 SP-7 SP-8 SP-8	SP-11 SP-12 SP-12 SP-12		
			TECHNOLOGY																1-9

LEGEND: Experiments Comprising Payloads Included in Study

Figure 2-4: RAM Payloads/Experiments Selected For Crew Function Analysis, With Correlation To Sortie Lab Payloads



by the composite experiment program. Descriptions within the Blue Book of areas of experimentation (usually at the FPE level) specified, on a preliminary basis, which of the "skills" were required for support, e.g., Biochemist, Astronomer, etc. It was recognized by some that these listings were not truly indicative of "skill" requirements but were merely references to the occupational and professional designations most closely associated with an area of research. It was on this premise that the need for a better method was based, initiating the NASw-2192 study.

Subsequent to the release of the Blue Book, several major definition and development studies, e.g., Shuttle Orbital Applications and Requirements (SOAR), Research and Applications Module (RAM), Life Sciences Payload Definition (LSPD), etc. released reports which also included crew skill listings. In all cases, the listings in these reports purported to be based on an analysis of personnel resource requirements, yet each case turned out to be a variation of the Blue Book listings. In no instance was any analysis documented in these reports to substantiate the crew skill listings.

To illustrate, Table 2-1 lists the "crew skills" as presented by the Blue Book, together with the listings found in various other study reports and documentation. As can be seen, there is very little difference between studies, with respect to the skill titles listed. The similarity extends, in some instances, even to the use of the same code numbers from one study to another. The LSPD list, of course, is much shorter, covering only Life Sciences research areas. Even those differences which do occur are, to a great extent, artificial, e.g., the combination of an electromechanical technician and an optical technician into electromechanical/optical technician.

Of even greater concern is the manner of specifying crew skills. Of the reports referenced herein, only the Blue Book admits that selection of some of the parameters (including skill requirements) is arbitrary. The remaining studies give the impression of analytically derived skill requirements, although these requirements are, in reality, a repeat of Blue Book data.

For example, the SOAR Final Report (Refs. 71 - 85) is comprised of many volumes devoted to presentation of requirements and recommendations for use of the Shuttle. Volume 1 (p. 20) describes how payload planning activities have to limit experiment accommodation on the Shuttle because of "crew skill" availability:

"...it was determined that an experiment crew limitation to two men had a definite effect on Blue Book payload accommodation.

Over a 5-day mission, the number of sub-FPE payload elements that could reasonably be accomplished was an average of two. These generally had to be single discipline or in closely related disciplines to minimize cross-training for crew skill requirements."

In this case, payload accommodation has been limited by crew skill requirements. In tracing the source of these requirements, one is led to Volume 1, Appendix B of the report, wherein "Crew Requirements" for each payload element are given.



TABLE 2-1: Comparison of Crew Skill Listings

		SOURC	E AND SKILL CO	DES*	
CREW SKILL TITLE	Blue Book (Ref. 1-8)	SOAR (Ref. 71-85)	RAM Phase B (Ref. 50-51)	Sortie Lab (Ref. 94)	LSPD (Ref. 51)
Biological Technician Microbiological Technician Biochemist Physiologist Astronomer/Astrophysicist Physicist Nuclear Physicist Photo Technician/Cartographer Thermodynamicist Electronic Engineer Mechanical Engineer Mechanical Engineer Electromechanical Technician Medical Doctor Optical Technician Optical Scientist Meteorologist Microwave Specialist Oceanographer Physical Geologist Photo Geologist Behavioral Scientist Chemical Technician Metallurgist Material Scientist Physical Chemist Agronomist (Agronomer) Geographer Astronomer Physicist/Astronaut Astrophysicist Astronaut	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27	6 9 10 12 14	1 2 5 19 8 16 14 15 3 6 10 11 4 20 17	14  19  12 12 18/16  5  4  7  6  21  17 15 22  11 1	1 2 3 4
EVA Backup Pilot/Navigator Hydrologist Life Science Technician Geologist Electromechanical/Optical Tech. Chemist General Skill Electrical Engineer Agronomist/Forester Cloud Physicist General Scientist	·		9 7 18 27	10 9 3 8 13 23	0

<sup>\*</sup>Numerals are code numbers assigned in source document.
Symbol • indicates callout by title without code number.



The crew skills are those shown for SOAR in Table 2-1 of this report and the data in Vol. 1, Appendix B, of the SOAR report are reprinted from the MMC "Green Book" (Refs. 9, 10), which states in the introduction: "All requirements are based on the January 1971 Reference Earth Orbital Research and Applications Investigations (Blue Book)." Thus, payload accommodations in the SOAR study are constrained by occupational titles in the Blue Book, for which no clear definitions are provided.

Another example is found in the RAM Phase B Study Report (Ref. 30), Trade Study TS-1100-03, Shuttle-Supported Sortie Mission Compatibility. The objective of this study was to "develop rationale for determining experiment suitability to Shuttle-supported missions..." One of the screening criteria was crew requirements. The trade study concluded that all individual experiments are compatible with a crew of two or less, which is not surprising since the authors assumed "...for any given sortie mission, the two crewmen assigned to experiments can possess as many skills as necessary for any selected experiment." Other assumptions were equally loose, including the use of a skill assignment to experiments, such assignment obviously being based on Blue Book and Green Book data and not on actual evaluation of experiment requirements. Assumptions made regarding cross-training capability are equally unjustified.

Other program and study documentation has treated the topic of skill requirements in the same manner as discussed above. Skill requirements are being utilized in these studies — as well they should be — but there has been insufficient effort to determine what the actual skill requirements are. Decisions are being made based on loosely derived crew skill requirements. Evidence that the crew skill listings are merely being passed from one study to another may be found by examination of the preliminary Sortie Lab program data (Ref. 116) shown in column 4 in Table 2—1. The similarity between this list and previously published lists will undoubtedly become even greater when the Sortie Lab data is expanded to include the Life Science experiments. The well known tendency to put off the application of efforts to "personnel subsystem" factors is again in evidence.

To summarize, there is considerable evidence in published study reports that crew skills needed for on-orbit experimentation were not being determined through actual analysis of requirements. The impact of these practices, if not corrected, will be felt throughout all levels of system definition and development, as well as in the missions themselves. Provisions for the needed crew skills will greatly affect the quality and quantity of data return from each mission. Timely attention to this area of definition will often prove decisive in determining levels of automation in mission equipment, as well as weight, power, and other "engineering" parameters. Dependence on extensive cross-training of crew members is not the answer either, especially since the skills which the crew is to be trained to perform are not known. In addition, NASA has stated that these experimenters will not be astronauts but scientists from the industrial and academic communities. This will leave little opportunity to close all the skill gaps by cross-training.

1



Reflecting on the data presented above, it becomes obvious that in order to determine the skills that would be required, the activities and tasks generating the requirements for particular skills need analysis. Further, skills should be defined in such a way that they are independent of the connotations and associations of "accepted" occupational and professional titles. In addition, skills should be defined at a level that is independent of factors such as crew size, specific equipment configurations, mission duration, experiment grouping within the payload, or facility characteristics. This led to the concept of "task-skills". The procedural flow for accomplishing skills determination using this method is shown in Figure 2-5.

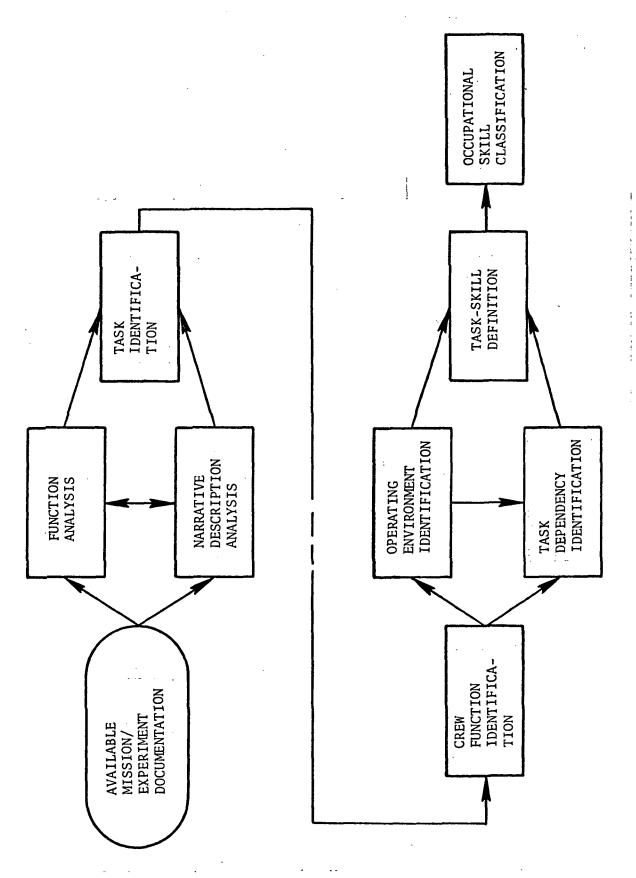
### 2.2.2 Task-Skill Definition

The concept, basically, is to describe the skill requirement in terms which identify a particular function (e.g., inspect, control, evaluate) which a man must perform and the item or factor (e.g., spectrometer, subsatellite, stellar data) with respect to which the function must be performed. A task-skill is, in effect, a brief phrase or description which denotes a specific equipment— or procedure—oriented crew function (e.g., Spectrometer Inspector, Subsatellite Controller, Stellar Data Evaluator).

Task-skills can be defined at any level which can be supported by the input data. Very preliminary definition can take place even before the specific types of equipment involved in a task are identifiable. For example, it may be known that an experiment on-orbit will require various types of observational equipment, and that, at some point in the mission, the equipment will need to be inspected for damage, cleanliness, etc. A general task-skill requirement can be stated immediately, e.g., Observation Equipment Inspector. Later, as the experiment becomes better defined, more specific task-skill titles can be substituted, e.g., Optical Equipment Inspector, Electronic Sensor Inspector, etc. When specific types of equipment are identifiable, these become the level of definition of the task-skill, e.g., Spectrometer Inspector, Telescope Inspector, etc. When the nature of the crew function with regard to an item of equipment is sufficiently complex and/or demanding, task-skill identification may be required at an even more specific level, e.g., Ion Mass Spectrometer Repairer. The task-skill should be defined at the lowest level which will incorporate the essence of the demands of the equipment item (or other factor) and the function to be performed on the knowledge, experience and training of the crewman.

In the preceding discussion, frequent reference has been made to "crew function" and "equipment item" in the context of task-skill development. These phrases have been formalized and incorporated in the task-skill development methodology. Crew functions are discussed in paragraph 2.2.3. The "equipment items" or other factors are called Task Dependencies, and these are discussed in paragraph 2.1.4. To complete this general discussion of the task-skill identification concept, paragraph 2.2.5 is comprised of a brief discussion of the "Operating Environment", the environment in which the crewman performs his assigned function, and paragraph 2.2.6 is a discussion of "Occupational Skills Classification", the final step of the task-skill definition technique.





Procedural Steps for Task-Skill Requirements Identification Figure 2-5:



### 2.2.3 Crew Function Taxonomy

Essential to the identification of task-skills is the knowledge of the kinds of functions which a crewman is expected, or may be expected, to perform. tion of these functions can take many forms but should, to the greatest extent possible, be mutually exclusive, provide insight to the intellectual, sensory, and/or motor activities of the crewman, and be independent of the nature of the equipment or experiment with respect to which the function is to be performed. During this study, and for purposes of utilization in the task-skill identification, the taxonomy of crew functions shown in Table 2-2 was developed. Definitions of these crew functions are included as Appendix B to this report.

Crew functions 01 through 28 were identified as being generally applicable to a wide range of experiments. Crew function 29 (Unknown) is reserved for cases where the nature of the crewman's function cannot be determined. Crew Function 30 (Subject for Experiment) is used to identify instances where a crewman's activities were being evaluated as part of experiment conduct. Crew functions 31 through 34 were assigned during the detailed analysis of Life Science experiments to cover rather unique crew functions which did not "fit" the basic crew function taxonomy. An example of a Crew Function Worksheet analysis, assigning basic functions, crew functions, and operating environments to the identified task statements, is shown in Figure 2-6. These worksheets are utilized to make a preliminary assessment of the relationships between the identified task statements and the appropriate modes of operation, basic functions, crew functions, and environments. This provides the analyst with an overview of the experiment prior to initiating the detailed task-skill requirements analyses.

TABLE 2-2: CREW FUNCTION TAXONOMY

No.	Title	No.	Title
01	Status Monitoring	18	Unstow
02	Observation	19	Clean and Decontaminate
03	Inspection	20	Assemble
04	Pattern Recognition	21	Disassemble
05	Communication	22	Translocation
06	Data Processing	23	Deployment
07	Fault Isolation	24	Retrieval
08	Calibration	25	Locomotion
09	Alignment	26	Removal
10	Control	27	Replacement
11	Evaluation	28	Repair
12	Analysis	29	Unknown
13	Decision Making	30	Subject for Experiment
14	Test and Checkout	31	Occupy
15	Actuation	32	Wear
16	Deactuation	33	Receive
17	Stow	34	Donate

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22. Close airlock	x   x		×	_				X			<u> </u>									H	×			×		H		
ock to space	×		×	$\vdash$		$\vdash$	H	×	$\vdash$		H		Н		Н	×				H		H		×		H		
24. Open airlock outside gate	X X		ľ×ľ	Н				Ž	Н		H		Н	П	Н	ř				Ч		-		×		Щ		
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26. Activate instrument power	XX		×	Н		Н		3	Н		Н	$\square$	$\exists$		Н	ΙX				Н	П	Н		×				
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instrument	X X		X	_				X			_									_	_			×		_		
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properly	χX		x	H		Н		X	Н		Н				×	$\Box$	_			_	Į			×		Ч		
30. Initiate data transfer to magnetic tape	X			X.		Н			Н		Н		Н		Н	×	_		7	Н		Н		×				
31. Place calibration lamps in front of				Н		Н			Н		Н		$\dashv$		Н		-			Н		$\exists$		$\dashv$		4		•
entrance apertures	ХX			_		X	×	$\exists$	-				_		-	Ц	-			$\dashv$	×	_		×		-		
32. Calibrate instruments, in situ	XX	$\exists$	$\Box$	$\dashv$	╛	×	×	$\exists$	Н	П	Н	Д	×	$\Box$	$\dashv$	$\Box$	$\dashv$	$\Box$		4				Ä		$\dashv$		-
33. Interchange Infrared Interferometer				$\dashv$		$\dashv$			$\dashv$		$\dashv$	$\exists$		$\Box$	┪	$\Box$	1	$\Box$		-		-	⇉	$\dashv$		$\dashv$		
spectrometer detectors	X			Н		$\dashv$		3	$\dashv$		Н		$\exists$		-	×				4		_		×		$\dashv$		
34; Interchange Scanning Grating Spectrometer	<u> </u>		耳	Н		$\dashv$	╛		$\dashv$		$\dashv$	$\Box$		$\Box$	$\dashv$	$\Box$		Ц		$\dashv$		$\dashv$		$\dashv$		4		
gratings	×			4		$\dashv$		3	$\dashv$		-	$\exists$	$\exists$	$\exists$	$\dashv$	X		$\Box$	1	4		-	$\exists$	×	$\exists$			
35. Control wavelength scan rate on SGS	×			A		4		7	$\dashv$		$\dashv$		_^	$\Box$	┥	$\Box$	7		7	4		Н		<u> </u>		-		
36. Interchange SGS detectors	X							×	Н						Н	×			_	4	_	_		×		4		
37. Interchange SGS photomultipliers	×			Н		$\vdash$		×	Н		H	П	Н		Н	X				_		_		X				
38. Interchange SGS electronics	ļX			H		$\vdash$		X	Н		$\vdash$				_	l x l	~	1		_	_	_		X		_		
39. Attach camera to SGS	X X		ł x	Н		Н		$\Box$	Н		Н				Н	П				_	x			X		Н		
40. Record SGS spectrum photographically	x			Ť		$\dashv$		$\exists$	$\dashv$		Н				Н	I x		1		4				×				
41. Observe low light level auroral emissions	_					_			_											_		_		H				
using TV	X	Н	П	Ľ		Н		$\Box$	¥		Н	П	Н		Н	Д				Н		Н		X		4	•	
42. Mount high purity target foil outside of				-		$\dashv$		$\Box$	ㅓ		Н		_		$\dashv$	П				4		-		$\dashv$			× .	
s/c	XX		X	-		Н		П	-		$\vdash$	Г	Н		Н		_	×	×	<u> </u>	×	-		$\vdash$	×			

See Reference No. 68 for a complete explanation of the use of a Crew Function Worksheet Mode Applicability: A = Shuttle Sortie; B = Shuttle-Supported Free Flyer. £665

Figure 2-6: Example of Crew Function Worksheet for Experiment Tasks

Explanation of "Basic Functions" is given in Appendix C of this report.

Operating environments are explained in paragraph 2.2.5 of this report. Definition of Crew Functions is given in Appendix B of this report.

### 2.2.4 Task Dependency Reference List (TDRL)

Within the context of task-skill identification, a "task dependency" is a factor upon which successful performance of a crew function depends. The nature of such factors covers a very broad range, and all have implications for the knowledge, training, and/or experience which must be possessed by the crewman. Any efforts to identify crew skill requirements must, of necessity, identify the factors upon which performance depends. Further, these factors, or task dependencies, must be identified at the most specific level supportable by the input data, but they must not preclude the progress of the analysis if specific identification is not possible. To achieve this goal, a determination was made of the major types of factors upon which successful performance depended. These major factors are categorized as:

- 1. System and Facilities
- 2. Experiment Equipment and Materials
- 3. Object or Area Under Investigation
- 4. Support Equipment
- 5. Environment
- 6. Mission Considerations

The six major categories of task dependencies are divided into subcategories based on major functional differences. Then, as each new item of equipment or object of investigation is identified, it is placed in one of the subcategories. Each item is given an alphanumeric code designation to permit ready recognition of the category and subcategory to which it belongs and to promote rapid data retrieval. In addition to these three levels, a fourth level is assigned, where appropriate, to identify specific equipment items or characteristics. For example, within the major category of "Experiment Equipment and Materials" (#2), the second level might be "Observation Equipment" (#2.A), and the third level of dependency could be "Spectrometers" (#2.A.03). The fourth level, then, would be various specific types of spectrometers (e.g., "Ion Mass Spectrometer"), and each type would be assigned a dash number (e.g., 2.A.03-6). An illustration of the structure and use of the Task Dependency Reference System is shown in Figure 2-7. A complete listing of all Task Dependencies identified to date (NASw-2192; NAS8-28359) is incorporated in this report as Appendix D.

The utilization of the TDRL enables the analyst to specify the equipment, environment, conditions, etc. on which task performance depends to whatever level of specificity is supportable by program definition status and/or is needed by the purpose of the analysis. There is no need to determine precise equipment characteristics or to obtain serial numbers in order to document the item's relationship to the task. In fact, an equipment item which does not yet exist can be included and can have the same consideration as those which are well defined. The TDRL further recognizes and incorporates the less tangible or less visible factors which affect task performance, (e.g., an area of knowledge) and ensures that consideration is not limited to a specific item of hardware. It is expandable, condensable, and flexible and is designed to be a tool to aid in the conduct of analyses rather than a documentation of what has transpired.

Figure 2-7: Example of Task Dependency Reference List (TDRL)

Radiation (Ionizing)
Radiation (Radio Frequency)
Extravehicular Environment (B + C + D \* [F + G])
Earth Atmosphere

Acceleration and Gravity Illumination

Temperature

**ベモンロミドウギーシャン** 

Pressure

Fire and/or Explosion Hazard Intravehicular Activity Environment (B + C + D) Object/Vehicle Relationship

Mission Considerations

A. Mission Events



As described in paragraph 2.2.2, the title of the primary task dependency and the appropriate crew function title are combined to prepare the task-skill title. The actual procedure used for accomplishing this is fully described in Reference 68.

### 2.2.5 Operating Environments

The "Operating Environment" was defined in this study as the environmental conditions under which the crewman must perform his assigned functions. The purpose of this identification is twofold. First, by identifying the operating environment, constraints imposed by the environment on task performance can be identified. Secondly, identification of the operating environment provides an input to the Task Dependency Reference List, since "Environment" is one of the six major categories of dependencies (see Figure 2-7).

The analysis conducted during the original study determined that there were eight separately identifiable operating environments, as shown and defined in Table 2-3. Since all experiment module crew tasks are performed on-orbit, zero gravity was assumed to be the usual environment. For this reason, the gravitational environment was identified in the task-skill analysis only when it was other than zero gravity. The listing in Table 2-3 is not intended to be all inclusive but, rather, to account for those operating environments identified in experiments analyzed to date.

The manner of incorporation of operating environments into the task-skill requirements analysis is fully described in Reference 68. As a general rule, however, the operating environment data is used in evaluation of the task-skill characteristics, although it is not reflected in the task-skill title.

### 2.2.6 Occupational Skill Classification

An important feature of the Task-Skill concept discussed in the preceding paragraphs is the availability of a method by which the skill requirement identification at the task level can be realistically equated to the source of these skills for specific missions, i.e., the scientists, engineers, and technicians who will ultimately be needed to perform the on-orbit activities. An initial premise was that requirements for experiment or mission-specific training should be held to a minimum and that the experiment crew would be selected from the scientific and technical population to provide the best "fit" to the required task-skills. Various methods of job-skill and occupationalskill definitions were evaluated, including those presently in use by the military services. As a result of those evaluations, it was decided that the broadest, most easily applied method was that being utilized by the U.S. Department of Labor. This method is described in detail in the two volume Dictionary of Occupational Titles (Refs. 20, 21) issued by the Manpower Administration of the Labor Department. The <u>Dictionary</u> contains titles and definitions of 21,741 separate occupations, plus 13,809 additional, or alternate, titles for those occupations. In the Dictionary, a six-digit coding system is used, with the first three digits identifying the applicable occupational group



TABLE 23: OPERATING ENVIRONMENT TAXONOMY AND DEFINITIONS

OPER. ENVIR. NO.	OPERATING ENVIRONMENT TITLE	OPERATING ENVIRONMENT DEFINITION
00.	ZERO GRAVITY	An environmental condition in which gravitational and other external forces acting on the experiment module or scientific crew member produce no stress, either internal or external; weightlessness.
01.	SHIRTSLEEVE	A "shirtsleeve" environment is one in which the facility housing the crew provides all the life support and temperature maintenance. There is no requirement for pressure suits or umbilical connections. Except for zero gravity or low gravity, it is a normal, earth-type environment. A further exception may be the existence of a one gas atmosphere at low oxygen pressure.
02.	<u>EVA</u>	In this environment, the crewman is in full pressure suit and is operating external to the spacecraft (i.e., in free space). Life support may be
	(Extravehicular	provided either by umbilical connection or through utilization of an independent, portable Extravehicular Life Support System. Further, the
	Activity)	EVA crewman may be either tethered or untethered depending on the particular function he is performing.
03.	IVA	This environment is essentially the same as the EVA environment except that the crewman remains within the structural envelope of the spacecraft.
	( <u>Intravehicular</u>	The environment will be unpressurized, full pressure suits are required,
	Activity)	and either umbilical or portable life support systems must be utilized.
04.	POSITIVE GRAVITY	An environmental condition in which gravitational or other external forces are acting on the experiment module or scientific crew member in a "downward" or footward direction. The force is defined as something greater than 10 <sup>-2</sup> "G", and may range well upwards of one "G". The G-forces may be a result of vehicle maneuvering, terrestrial gravitational pull, or an experimental procedure (e.g., a centrifuge).
05.	NEGATIVE GRAVITY	An environmental condition in which gravitational or other external forces are acting on the experiment module or scientific crew member in an "upward" or headward direction; the opposite of POSITIVE GRAVITY. The G-forces may be the result of vehicle maneuvering, terrestrial gravitational pull, or an experimental procedure (e.g., a centrifuge).
06.	ROTO-GRAVITY	An environmental condition wherein G forces are acting on the body through rotation or spinning of the body. The axis of rotation passes through some part of the body, or, because of body orientation to the axis, the forces act differentially on various parts of the body. ROTO-G may include both POSITIVE and NEGATIVE G forces.
07.	TOXIC ATMOSPHERE	An environmental condition in which the atmosphere upon which the crewman depends contains, or has a high potential for including, elements or materials which are capable of causing serious injury or illness. Such elements may be either gaseous or particulate and of chemical or biological origin.
08.	SPECIAL GARMENT	A condition in which the environment immediately adjacent to the body is altered by the wearing of some special types of clothing or protective gear beyond that which qualifies as "shirtsleeve". The EVA and IVA environments are specifically excluded from this category.



and the last three digits providing a profile of characteristic worker traits, interrelationships, and job complexities. A diagrammatic summary of the classification method is presented in Figure 2-8. It is estimated that the occupational group definitions in the Dictionary will encompass greater than 90% of the required on-orbit research and applications skills, and the method will be applicable to all skill requirements. Figure 2-9 illustrates the application of the classification method in determining the appropriate occupational skill category for a particular task-skill.

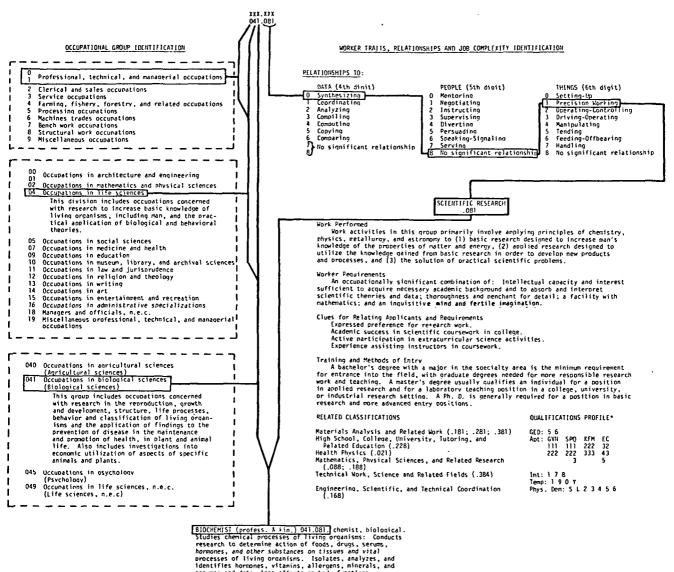
The actual process of the Occupational Title Search is not as complex as it may appear in Figure 2-9, because only the listings which do fit will be documented. This example has also documented the titles which would normally be discarded as not applicable.

# 2.2.7 Skill Groupings

Using the methods described in the preceding paragraphs, it is to be expected that an occupational skill will be common to many task-skills. This will provide for the first level of combining, which will be necessary in determining crew skill complements for planned missions. Further combinations are possible through groupings of all occupational titles which have the same 6-digit code number within areas of work. This kind of grouping is illustrated in Figure 2-10 for occupational code #003.081, the code number for the Radar Engineer in the preceding example. Each of the titles in this grouping are interrelated by the basic nature of the work and by the applicable worker traits profile. Suitable specialized training may also be required to satisfactorily fill the needs of the composite task-skills, however. Further combinations are possible, of course, but the interrelationship weakens with each level of combination, leading to greater requirements for specialized training. When such further combinations are needed, however, they are accomplished by grouping all titles which have the first three digits (e.g., 003.xxx) in common, with variations in the last three digits. Still more combinations may be made by comparing the job traits, etc., but recognizing that more extensive specialized training will be required.

A more complete description of the application of occupational skill classification and grouping to the Task-Skill Requirements Analysis is included in Reference 68.





SIOCHEMIST (profess. & Fin., 041.081.) chemist, biological. Studies chemical processes of living organisms: Conducts research to determine action of foods, drugs, serums, hormones, and other substances on tissues and vital processes of living organisms. Isolates, analyzes, and identifies hormones, vitamins, allergens, minerals, and enzymes and determines effects on body functions. Examines themical aspects of formation of antibodies, and conducts research into chemistry of cells and blood corpuscles. Studies chemistry of body processes, such as breathing and digestion, and of living energy chances, such as growth, aging, and death. May specialize in particular area of field of work, and be designated CHEMIST, CITIALAL; CHEMIST, ENZYMES; CHEMIST, PROTEINS; CHEMIST, STEROIDS.
May clean, purify, refine, and otherwise prepare pharmaceutical compounds for commercial distribution, develop new drugs and medications, and be designated CHEMIST, PHARMACEUTICAL.

 Profile entries refer to levels of preparation or demand per General Educational Development (GED), Specific Vocational Preparation (SVP), Aptitudes (Apt), Intelligence (Int), Temperaments (Temp) and Physical Demands (Phys. Dem).

Figure 2-8: Example of Approach to Occupational Group Classification (Biochemist)



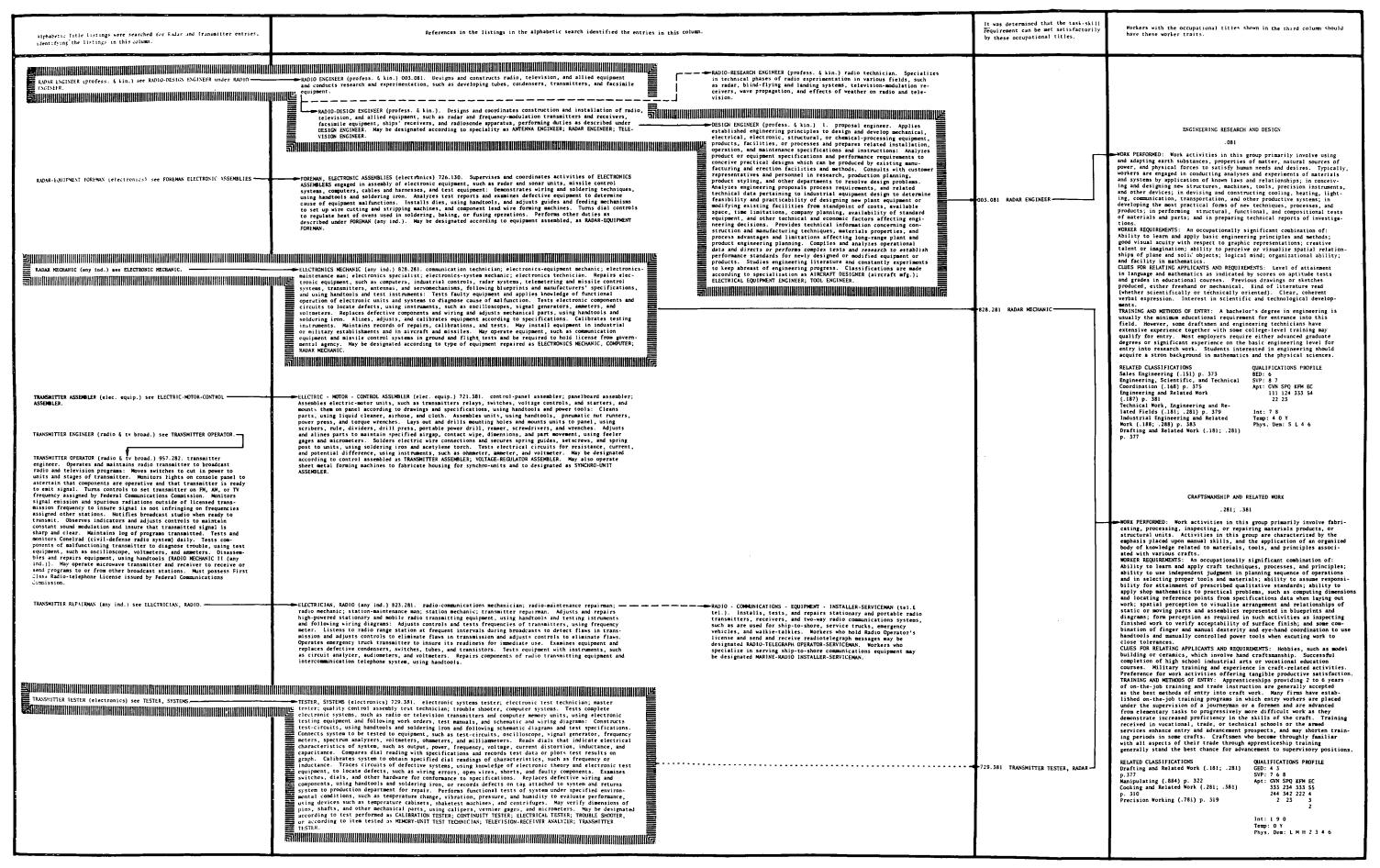


Figure 2-9: Occupational Skill Classification: Occupational Title Search. (Search for Radar Transmitter Operation Monitor. Task Skill No. 0812)



```
ENGINEERING RESEARCH & DESIGN®
00
         ARCHITECTURE AND ENGINEERING
01
003.
         Electrical Engineering
003.081 ELECTRICAL ENGINEER (profess. & kin.)
         ELECTRICAL-EQUIPMENT ENGINEER (profess. &
            ELECTRICAL-PROSPECTING ENGINEER (pet-
             rol. production)
            SIGNAL ENGINEER (profess. & kin.)
         ELECTRICAL-RESEARCH ENGINEER (profess. &
          kin.)
         ELECTRONIC ENGINEER (profess. & kin.)
            AUDIO ENGINEER (profess. & kin.)
         ELECTRONIC-ORGAN ENGINEER (profess. & kin.)
         ILLUMINATING ENGINEER (profess. & kin.)
            BUILDING-ILLUMINATING ENGINEER (pro-
             fess. & kin.)
            ILLUMINATING-RESEARCH ENGINEER (pro-
              fess, & kin.)
            INDUSTRIAL-ILLUMINATING ENGINEER (pro-
              fess. & kin.)
            OUTDOOR-ILLUMINATING ENGINEER (pro-
             fess. & kin.)
         POWER-PLANT ENGINEER (light, heat, & power)
         RADIO ENGINEER (profess. & kin.)
            RADIO-DESIGN ENGINEER (profess. & kin.)
            RADIO-RESEARCH ENGINEER (profess. & kin.)
         ROCKET-ENGINE-TEST ENGINEER (aircraft mfg.)
         TELEGRAPH ENGINEER (tel. & tel.)
         TELEPHONE ENGINEER (tel. & tel.)
            EQUIPMENT ENGINEER (tel. & tel.)
            LINE-CONSTRUCTION ENGINEER (tel. & tel.)
            TELECOMMUNICATIONS-SERVICE ENGINEER
             (tel. & tel.)
```

<sup>@</sup>Notes area of work

Figure 2-10: Occupational Title Grouping Within Areas of Work

# WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

**CONTRACT NAS8-28359** 

**FINAL REPORT** 

SECTION 3.0
RESULTS OF SKILLS ANALYSIS





## SECTION 3.0

#### RESULTS OF SKILLS ANALYSIS

#### 3.1 GENERAL

This section of the report presents the results of efforts under this contract to determine the applicable task skills, primary occupational skills, and mission occupational skills for two classes of orbital research utilizing the projected Sortie Lab. The disciplines — and Sortie Lab payloads — included are shown in Table 3-1. Rationale for exclusion of some specific payloads or experiments from these two disciplines is also given.

The approach which led to selection of these particular groups of experiments, as well as the methodology utilized in identifying the needed skills, is explained in Section 2.0 of the report. Within these two research disciplines, deletion of certain payloads was based on considerations such as their not being likely missions for the 1979 - 1982 time frame, or their unlikely selection as Sortie Lab missions. These two types of research present a significant contrast, in terms not only of the nature and objectives of the experimentation but also in terms of the types of equipment involved and the system constraints while research is in progress. The Earth Observations group, of course, utilizes the orbiting laboratory as a vantage point, sufficiently distant from the earth's surface that large areas may be observed, yet not so distant that the observing instruments and sensors cannot collect detailed data when appropriate. The nominal weightless environment is an imposition on the experiment crew as a fact of being in orbit, rather than a constraint on the system dictated by the experiment requirements. Minor changes in G-level will, in fact, occur almost continuously as the orbiting vehicle strives to maintain Z-local vertical during a data pass. In addition, the Sortie Lab Earth Observations facility is a combination of a relatively small pressurized module for housing the operating crew, and an external pallet on which the observation instruments will be mounted.

The Materials Sciences experiments, on the other hand, have no requirement for earth viewing, and distance from the earth's surface is determined by orbital dynamics. A nearly perfect zero-G condition is a constraint imposed on the system by the requirements of the experiments. During some of the more critical phases of some experiments, even movements about the orbital laboratory by the experiment crew could conceivably cause disturbances in the materials being processed, affecting the resultant data. (This factor, not incidentally, increases the desirability of a centralized control/display console for Materials Sciences experiments; see Section 4.0). The Materials Sciences facility is planned as a totally pressurized module, requiring no external pallet.



TABLE 3-1: Screening of Payloads and Experiments in Earth Observations and Materials Sciences

	r	J																						
NAS8-28359 Skills Analysis	Reason for Exclusion*	Not scheduled for "early" mission.	Not scheduled for "early" mission;	וזררים כופא מכרואוראי			Not scheduled for "early" mission.	At time of study baseline, experiment	descriptions were inadequate. Not	believed to be scheduled for an early mission.			Not cohodulos for Heart-1	NOC Scheduled 101 eally mission.										
NAS 8-	Excluded	×	×				×	×	×	~ \x			,	∢										
,	Included			×	×	×							×		×	*	×		×	×			×	×
Sortie Lab Program (Ref. #157)	Payload Experiment	Meteorology and the Atmospheric	World Land Use Mapping	•—	kesource kecognition and Identification	Natural Disaster Assessment and	Ocean Resources	Atmospheric Cloud Physics	g Drop Exp	Droplet Charging Experiment		logical Experiments	(1) Separation of Biologicals (2) Preservation of Biologicals	itation Experiments	Prepara		(3) Some Crystals	Ħ	Composite Material		ow Temperat	eriments	(1) Physics of Fluids	
Š		E0-1	E0-2	E0-3	크 - - -	E0-5	E0-6	E0-7	E0-8	E0-9	1	MS-1		MS-2				MS-3			MS-4			
<b>L</b> FINE	pisci			suo	kep kep		QP		·					gu sət								W		

\*Early Shuttle missions were arbitrarily defined as those being planned for the first four years of Shuttle operation, i.e., 1979 - 1982.



Thus, while the selection of these two research areas is certainly not all-inclusive of projected Sortie-Lab payloads and experiments, it does cut across a broad range of types of activities and conditions of research. The specific skill-related data for the Earth Observations payloads is presented in Section 3.2; that for Materials Sciences payloads is presented in Section 3.3.

#### 3.2 EARTH OBSERVATIONS PAYLOADS

Three Earth Observations experiment areas, designated for flight as Sortie Lab payloads, were analyzed in detail:

EO-3 Air and Water Pollution

EO-4 Resource Recognition

EO-5 Disaster Assessment

# 3.2.1 Task Statement Screening

The Crew Function Worksheets, an example of which is illustrated in Figure 2-6, were first screened to eliminate duplication of task statements and to delete any task statements which were clearly contrary to published guidelines (Refs. 46, 48, 49, 92, 112, 114, 116, 119) for early Sortie Lab missions. Examples of the former are "Set up observation equipment" versus "Set up experiment equipment". The broader task statement was generally selected, since it encompassed a greater variety of payload equipment. Deletion of duplicative and partially duplicative task statements avoided incurring artificially high frequencies of identical crew functions, task dependencies, and task-skills. Although actual frequency counts were not made (since task repetition, which would certainly affect frequencies, could not be factored in), subjective judgments of frequencies, especially for task-skills, did influence choices in the grouping of primary occupational skills into mission occupational skills. Task statements which were deleted, based on guidelines, tended to be those which were oriented toward longer duration missions or which were dependent on types of support equipment being present which were not likely to be orbited on the more austere early missions. In the long-duration mission category were all "scheduled maintenance" tasks (Basic Function 09), since it was unlikely that any equipment would be orbited which would require scheduled maintenance during a 7-day mission. This, of course, does not include requirements for cleaning, decontamination of equipment, etc., which would normally be part of the experiment shutdown procedures (Basic Function 05), when appropriate. statements in the "unscheduled maintenance" area (Basic Function 10) were originally planned for deletion as well, but those tasks relating to "repair" activities were partially reinstated based on the experiences of the Skylab 1/2 Mission. Even with only marginally adequate tools, in combination with knowledgeable crewmen, a mission which might otherwise be aborted or seriously degraded because of failure of some critical item of equipment can still be successful.

At a more specific level, tasks which would require provision of supporting subsystems not expected to be included on early Sortie Lab missions were partially screened. Thus, tasks relating to operation of a photographic enlarger were eliminated. Tasks requiring development of film were left in,



since this may be a requirement as mission durations are gradually lengthened, but the Primary Occupational Skills which resulted were excluded from the groupings for determining Mission Occupational Skills.

# 3.2.2 Task/Skill Requirements Analysis

The remaining Task Statements were entered onto Task/Skill Requirements analysis sheets, an example of which is shown in Figure 3-1. The complete set of analysis sheets for the Earth Observations experiments analyzed is included in Appendix H of this report. Crew function codes and operating environment codes were taken directly from the Crew Function Worksheets. Primary and secondary task dependencies were identified according to the methodology previously described (see Section 2.2), and an appropriate Task-Skill title was entered, characterizing the function and the interface or activity which was to be performed. Subsequently, the Task-Skill titles were related (one-for-one) to Primary Occupational Skill titles.

#### FLIGHT EXPERIMENT TASK/SKILL REQUIREMENTS

DISCI	PLINE: EARTH RESOURCES				FPE: ES-1 E	arth Observation		MISSION	MODE: A - Shuttle Sortie	
EXPE	RIMENT AREA: Sortie Lab Pa	yload EO-	-4		EXPERIMENT:	4.0 - Resource Location and Ident	tification	BASIC FU	ONCTION: 06 - Experiment Conduct	
	CREW TASK STATEMENT	CREW	OPER.	TASK DEP	ENDENCY NO.	TASK - SKILL			PRIMARY OCCUPATIONAL SKILL	REFERENC
NO.	DESCRIPTION	FUNCT. NO.	ENVIR. NO.	PRIMARY	SECONDARY	TITLE	NO.	NO.	TITLE	NOTE NO.
17	(Continued)	01	01	2.B.04-18	2.F.01 2.F.03 4.B.01-2	Telescope Operation Monitor	2099	003.281	Instrumentation Technician	
19	Review data collected for quality and usefuliness	11	01	3.C.07	2.F.03-2 2.F.03-3 2.A.27-4 2.A.10-1 2.A.21-2 2.A.23 2.A.03-15 2.B.09 2.F.02-5 2.A.03-13 2.A.12-16 2.A.12-17	Land Use Data Evaluator	2108	024.081	Geophysicist	
20	Identify irrelevant data	04	01	3.C.07	2.F.02-5 2.F.03-2 2.F.03-3 2.A.27-4 2.A.19-1 2.A.23 2.A.03-15 2.B.09 2.A.03-13 2.A.12-15 2.A.12-17	Land Use Data Classifier	2115	024.081	Geophysicist	
21	Process film	06	01	4.8.08	2.A.27-1 2.A.27-2 2.A.27-3 2.A.27-4 2.A.27-5	Film Developer	0328	976.782	Film Developer	E0-2
REVI	SION NO:	REVIS	ION DAT	FF:	I p	REPARED BY: JHL/GRH/EMW	APPROVED	BY: GPH	SERIES ES-1-A PAG	E E0-4-06-1

Figure 3-1: Example of Task/Skill Requirements Analysis
Data Sheet, Earth Observations



## 3.2.3 Earth Observations Skill Requirements

## 3.2.3.1 Air and Water Pollution (EO-3)

The Air and Water Pollution experiment analysis resulted in the identification of 156 different task-skill titles, which were correlated to fourteen (14) different primary occupational skills. Payload EO-3 task-skills and their respective primary and mission occupational skills are included in the listing in Table 3-2. Determination of the appropriate mission occupational skill was made as described in Section 2.2. Actual groupings which took place are illustrated in Figure 3-2. As shown, the analysis leads to the conclusion that all of the experiment tasks for payload EO-3 can be accomplished by a crew complement with the following Occupational Skills:

#003.281 Instrumentation Technician #024.081 Geophysicist #828.281 Electronics Mechanic

As noted in Figure 3-2, some cross-training will be required to adequately reflect the Primary Occupational Skills in the selected Mission Occupational Skills. It should be understood that this does not necessarily represent a crew complement of three individuals, i.e., one with each of the listed MOSs. Until such time as detailed experiment timelines and workload analyses can be accomplished, such a conclusion would have no validity.

## 3.2.3.2 Resource Recognition (EO-4)

Analysis of the Resource Recognition experiment resulted in the identification of 144 different task-skill titles, which were correlated to thirteen (13) different Primary Occupational Skills. Payload EO-4 task-skills, and their respective primary and mission occupational skills are listed in Table 3-2. Selection of the appropriate MOS was made in accordance with the methodology discussed in Section 2.2. Groupings which resulted are the same as those for payload EO-3, as illustrated in Figure 3-2:

#003.281 Instrumentation Technician #024.081 Geophysicist #828.281 Electronics Mechanic

Cross-training requirements will be essentially the same as for payload EO-3, although perhaps not quite as extensive. Also, as discussed in paragraph 3.2.3.1, this listing is for a complement of occupational skills and does not necessarily represent a crew of three individuals.

## 3.2.3.3 Disaster Assessment (EO-5)

Experiment task analysis for this payload resulted in the identification of 264 task-skills. Using the techniques described in Section 2.2, these were



TABLE 3-2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).

	TASK - SKILL	PAYLOADS/EXPERIMENTS @	Air & Water Pollution	Resources Recognition	EO-5 Disaster Assessment					OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Ontical Technician	Surveyor, Geodetic	Geologist	Geophysicist	Meteorologist	Weather Observer	Calibrator	Camera Inspector	Inspector, Systems	Special Spaceflight Skill		
		ă	-3 A	1 1	-5					CODE	000.000	003.181	003.187	003.187	007 081	018.188	024.081	024.081	025.088	025.288	710.884	714, 684	722.281	xxx.xxx		
CODE	TITLE		E0-3	E0-4	읾				Ш	0	8	9	8	003			024	024	025	072	<u> </u>		828	×		
0001	Telescope Inspector				$\triangle$					<b>.</b>												4	$\mathbb{Z}^{\mathbb{Z}}$		П	
0004 0036	Telescope Ontics Cleaner Spectrometer Control Actuator	li .	大	份			243 313	+		1			#	- 1	3	1					#	*: -		16	H	+
0038	Spectrometer Fault Identifier		区				1	T					1	Ť	1						1				口	
0040	Spectrometer Tester	Ĵ	$\stackrel{\wedge}{\mapsto}$	$\langle \cdot \rangle$		34				80			4		) <u>.</u>		ļĒ				4	4	×		$\sqcup$	1
0046	Film Cartridge Installer TV Camera Unstower		1	쒸	伏	+	+	+	Н		H	+	+	Ž Ž	4	$\vdash$	+	$\vdash$	$\vdash$	+	+	+	+-		${oldsymbol{H}}$	+-
0072	Spectrometer Calibrator		$\triangle$	$\Box$		丁	I					O									<u> </u>	士	X			土
0095	Spectrometer Optics Cleaner		长	台	$\downarrow$	-	+	╂-	Н			$\dashv$	+	-8	<u>X</u>	┼-	<del> </del>	Н	Н	4	+	+	+	<del>   </del>	$\vdash \vdash$	+
0096	TV Camera Optics Cleaner Camera Lens (Optics) Cleaner	100	K		立	7	1	de:		777 77.7		(A)	ी	- K	X) -	-	10		77	25	d	7	+		$\vdash$	100
0109	Spectrometer Module Remover			$\triangle$			I					Q	1	$\supset$	\$			33		4	1	1	1			工
0110	Spectrometer Module Installer TV Camera Module Remover		长	$\stackrel{\sim}{\vdash}$		-	4	+	Н			읶	-	1	١.	-	1.		2.4		$\frac{\cdot}{\cdot}$	4			$\vdash$	4
0111	TV Camera Module Installer		云			+	+	-		. 2		허	4	-6	₹-	+	-	7		+	+	4	+			+
0158	Camera Module Remover				Ň	$\Box$	Ţ	I				Ó	1	$\downarrow$	<b>₹</b>	1				$\Box$	$\Box$	I	1		I	
0160			K	刽	$\mathbb{R}$	4	+-	+	Н			의	4	-2	1 <u>C</u>	_	┞	Н	Н	+	4	+	+	Н	$\vdash \downarrow$	+
0187	Telescope Module Remover Telescope Module Installer		K	岗	分		╁	╁	Н		$\vdash$	d	+	-K	dõ		╁╴	Н	H	+	+	+	+-	$\vdash$		十
0204	Camera Mode Monitor		$\triangle$		$\triangle$	1	Ι.			v.v			1	Įģ.						$\perp$	$\perp$	I	I		I	I
0206	Radio Communicator Scanner Mode Monitor		싅		兴		-					- (	일.	-	90	-	Į.		28 28			4	+	H	+	+
0209	TV Camera Mode Monitor		云	Ħ	才	+	+	+	Н	48,1 ,54,1			+	-15	Ž	-				1	+	+	+		-	+
0245	Camera Control Actuator		$\bigcirc$	$\triangle$	$\triangle$	$\Box$	I			Š.				2							7	I	I		I	I
0265	Telescope Mode Selector Spectrometer Mode Selector		$\frac{1}{2}$	<del> </del>	쑤		+	-	Н	88. <sub>1</sub>		엉	4	-K	<del>}</del> ==	<del> </del>	$\vdash$	Š		2	+	4	+	H	+	┽
0267	TV Mode Selector				7	$\top$	十	T	H	Ì	-	허	+	≾	オ╴	$\vdash$	<del>                                     </del>		$\neg$	$\top$	十	+	┰	H	$\top$	+
0271	Camera Mode Selector		$\triangle$	$\triangle$	Ň		I						I	No.	1			X	O	$\Box$	$\bot$	$\bot$		П	$\perp$	I
0292	Camera Unstower		Ļ	$\frac{1}{\sqrt{1}}$	쓔		╀	┼	Н		H	+	4	₽	4-	├-	H	Н		+	-	5	-	┦╌┤	-	+
0294	Camera Inspector Telescope Aligner	25	区	N	7		+	1	$\vdash$	7280 S.C.	-	ot:	<b>%</b> (	$\downarrow$	1	-			(80	1	5	1	校		+	
	Telescope Unstower Telescope Control Deactuator				$\Delta$		T	Ľ		1 (8°)		1		Q		E					T	I			T	工
0320	Telescope Control Deactuator Film Processor *		$\Theta$	$\langle \cdot \rangle$	长	+	+-	+	$\vdash$	্		#	4	12	}-	-		8		+			-		+	
0335	Camera Controller:**.		$\bar{\Delta}$		7	1	T						S						ÿ.					O	土	
0336	Spectrometer Controller **		Ž		$\exists$	$\perp$	Ļ	L				$\bot$	1	Ţ	L			$\Box$	$\exists$	$\bot$	7	Ŧ	1	00	4-	T
	Telescope Controller ** TV System Module Remover		$\forall$	-	$\forall$		╁	╁	Н	ŀ	-	╗┼	+	+	40	-	Н	$\dashv$	$\dashv$	+	+	+	╌├─	Н	+	+
	TV System Module Installer		Z	H		$\neg$	$\dagger$	$\vdash$	$\dashv$		- (	읭	+	1	ð					1	士	士			土	士
	Spectrometer Control Deactuator		Ķ	$\Box$	$\overline{\lambda}$		Ţ	L	$\Box$			1		Ø	1	L				$\frac{1}{}$	+	1	_		+	1
0516	Meteorological Condition Observer  Computer Module Remover		K	X	쑤	+	+	₽	$\vdash \vdash$		$\vdash$	ो	٦		1	<del>  -</del>		4	0	4	+	+	+	H	+	+
0520	Computer Module Installer		$\overline{\wedge}$	☑	_	士						ŏt.	Ì	<b>)</b>   <b>&gt;</b>	1					1	士	1		口	工	工
0611	Radar Transmitter Unstower		П	Ļ	$\ddot{\downarrow}$	Ţ	$\bot$	1	Ц			4	-	Q		L			4		4	+	-		4	4
0613 0615	Radar Transmitter Tester Radar Transmitter Module Remover	4.	H	$\wedge$	长	+	╁	+	H	ë.		윉	+	$\stackrel{\triangleright}{\times}$	+	<del> </del>	$\vdash$	+	4	+	+	+	+-	-	+	+
	Radar Transmitter Module Installer			$\leq$	Ճ	1	I	匚		Į	7	ŏt	I	1>						I	I	I	I		工	I
0623	Radar Receiver Module Installer		П	¥	낒		+	+	$\sqcup$		{	$\mathfrak{A}$	#	-R	<del>]</del>	-	$\vdash$	4	-	+	+	+	+	$\vdash$	+	+-
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	Radar Receiver Tester Radar Transmitter Unstower				D	士	上			····			土	×				_	$\exists$	士	1	1	工	П	工	二
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	Radiometer Tester  Radiometer Unstower	1	Н	-4	*	+	+	1-	$\dashv$	ŀ	+	ĭ┼	+-	16	1-	Н	┈	-+	7	+	+	+	1		+	1

<sup>\*</sup>No Occupational Skill Assigned; see text, paragraph 3.2.1

<sup>\*\*</sup>No Mission Occupational Skill Assigned; see text and Figure 3-2

 $<sup>\</sup>ensuremath{\mathfrak{Q}}$  The skill listings for each experiment, individually, are included in Appendix C



TABLE 3-2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).
(Continued)

			_																						
	TASK - SKILL	PAYLOADS/EXPERIMENTS	Air & Water Pollution	Resources Recognition	Disaster Assessment				OCCUPATIONAL SKILLS	Ceneral Technical Skill	i C	Radio Engineer	Systems Engineer, EDP	Optical Technician	Surveyor, Geodetic	Geologist	Geophysicist	Meteorologist	Weather Observer	Calibrator	Camera Inspector	Inspector, Systems	Special Spaceflight Skill		
		PA			S.				CODE	000	003.181	003.187	003.187	007.081	018.188	024.081	081	025.088	025.288	710.884	714.684	781	×		
CODE	TITLE		E0-3	입	9				١ŏ	000	003	8	9 8	700	018	024	324.	025.	925.	2	714.684	722.281	XX.XX		
0644			$\Delta$		$\Delta$										Ď							1	18		
0653	Polarimeter Mode Monitor			Q	Ž.						*			1						I		I	$oxed{\Box}$		
0664	Radar Transmitter Control Deactuator  Radar Receiver Control Deactuator		-	宗	(			-	48	-			-K	4	1				-13	4		-	12		1
0672	TV Camera Control Deactuator		$\forall$	Ħ				+	48	+			- 13						- 12 7 12	ď	्री	<del>}</del>	12	H	1 8
0673	Radiometer Control Deactuator	3,333			$\triangle$			T	<b>]</b>						ľ		Ħ		T	Ī		士	Ť		
0683	Radar Transmitter Fault Identifier				$\triangle$	$\perp$	口	I	]		П	$\exists$	$\prod$	I	L			口	I	I	I	3	工	$\square$	
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0691	Radiometer Fault Identifier		$\triangle$	$ \Delta $	A			1	1					Ĭ						1		Ñ	1	$\Box$	
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0848	Camera Control Deactuator	i,:	囚	$\overline{\Delta}$	立		7	1	្រ			7	[2	1				<u> </u>	7 B	1	: 2				
0849	Scanner Control Deactuator			$\Delta$	<u>A</u>	100			ा			$\Box$	ĮŞ.	100					1	1	1	$\perp$	$\prod$		$\perp$
0852		13	$\Box$	$\stackrel{\hookrightarrow}{+}$	$\mathcal{A}$	12		44	4.5	$\Box$				4				4	4	+	4	-	-		-
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	Radiometer Data Quality Monitor	188	忧	-ť	7	1		+	100	H		7	8	1	1		H	+	+	+		1	1-1	Н	+
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0880				1				Ι	]				Ø	I			I	$\Box$	I	I	$\perp$	I	$\Box$	П	$\perp$
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0885	Telescope Fault Identifier Camera Fault Identifier	1	夶	米	+	+		+-	1	Н	$\vdash$	+		8	$\vdash$	$\vdash \vdash$	$\dashv$	+	十	+	+	***	H	Н	+-
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	Sferics Detector Fault Identifier	1	ķ		$\mathcal{A}$		H	T	1	П	1	4	-	1	Ц	$\sqcup$	4	4	+	+	4	8	╁┤	H	-
	Optical Equipment Fault Identifier	1	伿	糾	4	+-	├-├-	-	4	Н	$\dashv$	-	-	0	-	├ŧ	S.	-+	+	+	+	, W	+-	$\vdash \vdash$	+
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	TV Presentation Observer Scanner Presentation Observer	1	1	Λĺ	7	+-	- -	+	1	Н	$\vdash$	+	+	<del> </del>	Н		ह्य	十	_	$\dagger$	1	1	H	$\vdash$	_
	Primary Occupational Skill. = Mission Occupational Sk	ill	V.			ask	·Ski	ill	Req	uir	ed	bу	Pa	ylo	ad/	/Ex	cpe	rin	nen	ıt.					



TABLE 3.2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).
(Continued)

TASK - SKILL	PAYLOADS/EXPERIMENTS	8 Water Pollution	ources f	aster Assessment				STILLYS IN MOLEVALLED			Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Surveyor, Deodetic Geologist	Geophysicist	Meteorologist	Weather Observer Calibrator	Camera Inspector	Inspector, Systems	Electronics Mechanic	Spacerigni	
	PA			1				u c	1 6	181	187	187	281	181	81	08.1	988	288	684	281	18 3	<b>§</b>	T
CODE TITLE	1	9-3	E0-4	9	1			CODE	000 000	003, 181	003.187	003.187	003.281	007.081	024.081	024.081	025,088	710.884	714.	722.281	828.281		
0898 Radiometer Presentation Observer	1	<u>                                      </u>		<u>" </u>					0	10	9	9	<u> </u>		) C	8	9	9.	1		∞  >		3.138
0899 TV Camera Control Actuator	1			寸	-			1			Ž		8	1									<del>:  }</del>
0904 Scanner Module Remover			$\triangle$	$\Delta$						0	8		XI.										
0905 Scanner Module Installer 0908 Polarimeter Module Remover	4	$\triangle$	(4)	4	ျှ			48	L	Ŏ			XI.	1							13	42.	4
0908   Polarimeter Module Remover	<b>{</b>	K	兴	348	43		4	48	۱.	K		3	$\mathcal{A}$	118	4		23				44	+*-	
0914 Polarimeter Presentation Observer	il	人	Ħ	+		1 1	+	$\dashv$	$\vdash$	۲	Н	+	+	+	+	Ø	+	+	$\vdash$	$\vdash \vdash$	+-	++	+
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TABLE 3.2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).

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TABLE 3.2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).

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	TASK - SKILL	PAYLOADS/EXPER!MENTS	Air & Water Pollution	Resources Recognition	isdater Assessment					OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Kadio Engineer	Systems Engineer, EDP	Optical Technician	Surveyor, Geodetic	Geologist	Geophysicist	Meteorologist	Weather Observer	Calibrator	Camera Inspector	Inspector, Systems	Electronics Mechanic	Special Spaceflight Skill	
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2132	Meteorological Precursor Data Evaluator				7				4			_		1	_	L	1	×	O	0	4		1	4	4	1
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TABLE 3.2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).
(Continued)

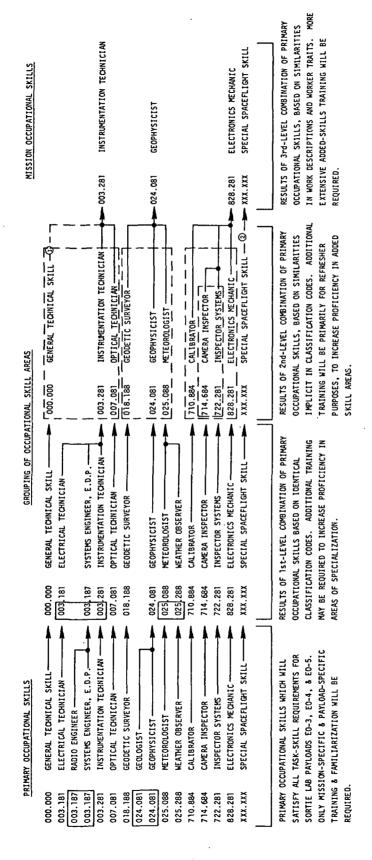
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TABLE 3.2: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5). (Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	Air & Water Pollution	Resources Recognition	Disaster Assessment					OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Optical Technician	Surveyor Geodetic	Coloniet	Geophysicist	Meteorologist	Weather Observer	Calibrator	Camera Inspector	Inspector, Systems	Electronics Mechanic	Special Spaceflight Skill	
		M <sup>X</sup>	E0-3 A							CODE	000.000	003.181	003.187	003, 187	003.281	018 188	024 081	024.081	025.088	025.288	710.884	714.684	722.281	828.281	XXX XXX	
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234	Drought Disaster Identifier Blizzard Disaster Identifier			4	$\frac{1}{2}$										7			N N	1		38		1	7	1	П
236	Telescope Data Quality Monitor		L				$\perp$	#	上				$\downarrow$		1	t	t		L	H		口	$\downarrow$	士	+	$\Box$
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GASSIGNMENT OF 000.000, GENERAL TECHNICAL SKILL, TO 003.281, INSTRUMENTATION TECHNICIAN, IS BASED PRIMARILY ON CONCURRENT REQUIREMENTS. OTHER 3rd-LEVEL SKILLS COULD SATISFY THE SKILL REQUIREMENT MITH EQUAL EASE. GASSIGNMENT OF XXX.XXX, SPECIAL SPACEFLIGHT

SKILL, HAS NOT BEEN WADE, SIMCE NO OTHER SKILLS ARE DIRECTLY RELATED. REQUIRENERITS FOR OPERATIONAL EFFICIENCY INDICATE THAT 024.081, GEOPHYSICIST, SHOULD RECEIVE SPECIAL TRAINING TO SATISFY THIS SKILL REQUIREMENT.

Derivation of Mission Occupational Skills for Sortie Lab Earth Observations Payloads E0-3, E0-4, and E0-5 Figure 3-2:



correlated to fifteen (15) different primary occupational skills. Table 3-2 shows the relationship of payload E0-5 task-skills, primary occupational skills, and mission occupational skills. Groupings which resulted are the same as those for payloads E0-3 and E0-4, as illustrated in Figure 3-2. These are:

#003.281 Instrumentation Technician

#024.081 Geophysicist

#828.281 Electronics Mechanic

Cross-training requirements for the technical skills (i.e., 003.281; 828.281) will be essentially the same as for payloads EO-3 and EO-4. Skill broadening requirements will, however, probably be much more extensive for the Geophysicist (024.081) due to the wide range of knowledge required for interpreting incipient disaster observations of all types. Conversely, since payload EO-5 is unlikely to ever be orbited independently of other experiment payloads (because of nonpredictability of disaster occurrence), the extent of such skill-expansion training for purposes of disaster assessment alone will probably be minimal. However, since the Geophysicist skill is a choice common to all three EO payloads, training should be sufficiently extensive to prepare the individual assigned this role for effective response when disasters (potential or actual) are observed.

As for the previous payloads, the listed Mission Occupational Skills should not be construed as representing three individual crew members.

#### 3.2.3.4 Multiexperiment Earth Observations Payloads

Although the task and skills analyses for the encompassed Earth Observations experiments were accomplished at the designated payload level, it is quite likely that a specific Earth Observations mission will include more than one of the separate payloads. Thus, EO-3 and EO-4 may be orbited together, as might be any other combination of the three payloads (EO-3, EO-4, EO-5). It is also possible that one or more EO payloads may be joined by one or more compatible payloads from other EO research areas or from other disciplines (e.g., Astronomy, Physics, etc.). Assuming the joint flight of payloads EO-3, EO-4, and EO-5, the commonality of task-skills across the three experiments was determined, as illustrated in Table 3-2. As can be seen, task-skill commonality is quite high when the primary task dependency is an equipment interface. Commonality is lower in those task-skills where a specific area of knowledge is the determinant, but still occurs frequently.

Still more significant is that even though the number of required task-skills for the three combined payloads increases to 343, the number of Primary Occupational Skills is only increased to sixteen (16), all of which are grouped into the same three Mission Occupational Skills:

#003.281 Instrumentation Technician

#024.081 Geophysicist

#828.281 Electronics Mechanic

Cross-training requirements obviously will be greatly increased in order to accommodate all task-skill requirements. However, as is illustrated in Table 3-3, there is little additional impact on skill requirements when a payload with two experiments is increased to accommodate all three experiments. This is especially true if, as is likely, one of the two initial experiments is Disaster Assessment (EO-5).



Table 3-3:	Comparison	of Single	Experiment	Payloads
to Multiple	e Experiment	t Payloads	Earth Obs	ervations

Pa	ylo	ads	Number	Number of	Number of
E0-3	E0-4	E0-5	of Task Skills	Primary Occupational Skills ①	Mission Occupational Skills ②
Х			156	14	3
	Х		144	13	3
		Х	264	· 15	3
Χ	χ		1 92	14	3
Χ		Х	331	16	3
	Χ	Х	308	16	3
Х	Х	Х	338	16	3

- ① Film Developer, 976.782 is not included; See paragraph 3.2.1
- 2 Special Spaceflight Skill xxx.xxx is not included; See Fig. 3-2

## 3.2.4 Earth Observations Payloads Skills Summary

The data which has resulted from the skills analysis makes it quite apparent that availability of the Occupational Skills required on orbit should present no major problem insofar as the EO payloads encompassed by this study are concerned, whether these payloads are orbited individually or in combination. In addition, indications are favorable that other Earth Observations payloads could be added without severely constraining the availability of needed skills. The question which cannot yet be answered, though, is whether the number of needed skills can be appropriately matched with the numerical crew complement. This, of course, will be dependent on factors such as permissible crew size, total workload, simultaneous tasks, etc. Nevertheless, advance planning and study can proceed with confidence that availability of the identified Mission Occupational Skills should be adequate to accomplish all predicted tasks for these Earth Observations missions without long-lead time, specialized training.

#### 3.3 MATERIALS SCIENCES AND MANUFACTURING PAYLOADS

Four Materials Sciences and Manufacturing experiment areas, designated for flight as Sortie Lab payloads, were analyzed in detail. These four payloads included nine (9) experiments, eight (8) of which were included in this analysis, as follows:

## MS-1 Biological Experiments

- (1) Separation of Biologicals
- (2) Preservation of Biologicals (not included)



## MS-2 Levitation Experiments

- (1) Glasses
- (2) Supercooling and Homogeneous Nucleation
- (3) "Some" Crystals

# MS-3 Furnace Experiments

- (1) Composite Experiments
- (2) Directional Solidification

## MS-4 Small and Low Temperature Experiments

- (1) Physics of Fluids
- (2) Zone Refining

The Preservation of Biologicals experiment (MS-1(2)) was not included in the analysis of skill requirements, since all indications were that it would not be present on any of the early Sortie-Lab missions.

## 3.3.1 Task Statement Screening

The Crew Function Worksheets, an example of which is included in Figure 2-6, were first screened to eliminate duplications of task statements and to delete any "out of guideline" tasks. The methods and rationale used in this screening were the same as for the Earth Observations experiments, described in paragraph 3.2.1.

# 3.3.2 Task/Skill Requirements Analysis

Task statements remaining after screening was complete were entered onto the Task/Skill Requirements analysis sheets. One of the MS analysis sheets is illustrated in Figure 3-3; the complete set of analysis sheets for the Materials Sciences experiments is included in Appendix H, a separate volume of this report. Crew function codes and operating environment codes were taken directly from the Crew Function Worksheets. Primary and secondary task dependencies were identified according to the methodology previously described (see Section 2.2), and an appropriate Task-Skill title was entered. The task-skill title chosen in each case was one which best characterized the function being performed and the interface, or dependent, factors. Subsequently, the Task-Skill titles were correlated to Primary Occupational skill titles on a one-for-one basis.

## 3.3.3 Materials Sciences Skill Requirements

## 3.3.3.1 Biological Experiments (MS-1)

Experiments included in this payload were:

- (1) Separation of Biologicals
- (2) Preservation of Biologicals

As stated above, only the separation experiment (Electrophoresis) was included in the Task/Skill Requirements analysis.



#### FLIGHT EXPERIMENT TASK/SKILL REQUIREMENTS

DISCI	PLINE: MATERIALS SCIENCES	AND MANUE	CTURING		FPE: MS-1 Mai	terials Sciences and Manufacturing in S	pace	MISSION	MODE: A - Shuttle Sortie	
EXPE	RIMENT AREA: Sortie Lab	Payload MS	5-4	1	EXPERIMENT:	4.0 Small and Low Temperature Experis 4.1 Convection of Fluids	ments	BASIC FU	NCTION: 04 - Experiment Setup	
	CREW TASK STATEMENT	CREW	OPER.	TASK DEP	ENDENCY NO.	TASK - SKILL			PRIMARY OCCUPATIONAL SKILL	REFERENCE
NO.	DESCRIPTION	FUNCT.	ENVIR. NO.	PRIMARY	SECONDARY	TITLE	NO.	NO.	TITLE	NOTE NO.
32	(Continued)	15	01	2.8.06-8	2.A.39-1 3.1.08 2.C.27	Interferometer Control Actuator	1616	003.281	Instrumentation Technician	
		26	01	2.A.39-1	2.8.06-8 2.0.13-1 2.0.13-2 2.0.13-3 3.1.08 2.0.27	Interferometer Remover	1604	003.181	Electrical Technician	
		27	01	2.A.39-1	2.8.05-8 2.0.13-1 2.0.13-2 2.0.13-3 3.1.08 2.0.27	Interferometer Installer	1601	003.181	Electrical Technician	
35	Calibrate instruments	08	01	2.0.27	4.C.01	Materials Analysis Equipment Calibrator	1046	710.881	Calibrator	İ
		08 08 08	01 01 01	2.D.18 2.A.30-1 2.A.39-1	4.C.01 4.C.01 4.C.01	Dispersion Control System Calibrator Calorimeter Calibrator Interferometer Calibrator	2313 0380 1605	710.881 710.881 710.881	Calibrator Calibrator Calibrator	
37	Define apparatus configuration	11	01	3.1.08	2.C. 27 2.0. 13-1 2.0. 13-2 2.0. 13-3 4.0. 22-1 2.0. 15 4.0. 13 2.0. 18 2.A. 17-7 2.A. 04-3 2.A. 30-1 2.D. 21-1 2.D. 21-2 2.D. 21-2 4.D. 21-2 4.D. 21-2	Fluid Convection Research Evaluator	1649	023.081 022.081	Physicist, Heat Chemist, Physical	
	ISION NO:		ION DAT	<u> </u>			ROVED		GRH SERIES MS-1-A PA	EMS-4,1-04-9

Figure 3-3: Example of Task/Skill Requirements Analysis Data Sheet, Materials Sciences and Manufacturing



The Biologicals Separation experiment analysis resulted in the identification of 118 different task-skill titles which were correlated to eight (8) different primary occupational skills. Payload MS-1(1) task-skills and their respective primary and mission occupational skills are listed in Table 3-4. Determination of the appropriate mission occupational skills was made through skill-grouping, as described in Section 2.2. The derivation of these groupings is illustrated in Figure 3-4. As shown, the analysis leads to the conclusion that all of the experiment tasks for payload MS-1(1) can be accomplished by a crew complement with the following Occupational Skills:

#003.281 Instrumentation Technician
#041.081 Biochemist
#828.281 Electronics Mechanic

As noted in Figure 3-4, some cross-training may be required to adequately reflect the Primary Occupational Skills in the selected Mission Occupational Skills. It should be understood that the identification of the three MOSs does not necessarily represent a crew complement of three individuals, one with each MOS. Until such time as detailed experiment timelines, workload analyses, sequence definitions, etc., can be accomplished, such a conclusion would be invalid.

## 3.3.3.2 Levitation Experiments (MS-2)

Experiments included in this payload, according to Sortie Lab references, were:

- (1) Glasses
- (2) Supercooling
- (3) "Some" Crystals

Since there were no previously documented experiment descriptions which conform directly with these titles, a comparison was made to documented experiments in order to determine those which would be suitable for purposes of task and skill requirements analysis. As a result, the following three experiments were selected:

- (1) Glass Processing: Preparation of Glasses
- (2) Crystal Growth: Supercooling and Homogeneous Nucleation
- (3) Crystal Growth: Crystal Growth from Solutions

# 3.3.3.2.1 Preparation of Glasses (MS-2(1))

Analysis of this experiment resulted in the identification of 165 different task-skill titles which were correlated to eight (8) different primary occupational skills. Payload MS-2(1) task-skills and their respective primary occupational skills are listed in Table 3-4, together with the primary and mission occupational skills for other portions of payload MS-2 and other MS payloads. The derivation of these skill groupings, which was accomplished at the total payload (MS-2) level, is illustrated in Figure 3-4.



TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).

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<sup>\*</sup>No Occupational Skill Assigned; see text, paragraph 3.2.1

the skill listings for each payload, individually, are included in Appendix C.



TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).

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TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).

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TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortle Lab Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).

(Continued)

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	TASK - SKILL	PAYLOADS/EXPERIMENTS	Separation of Biologicals	Preparation of Glasses	Supercool'g/Homog. Nuclea.	Crystal Growth/Solutions	Composite Materials	Fluids Convection	Crystal Growth/Melts	OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Radio Engineer Instrumentation Technician	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical	Physicist, Heat	Biochemist	Calibrator	Electronics Mechanic	בוברון סוווכא שבריומוויר				
		PAY	MS-1(1)	MS-2(1)	MS-2(2)	MS-2(3)	MS-3(1)	MS-4(1)	MS-4(2)	CODE	000.000	003.181	003.281	011.281	022.081	022.081	023.081	041.081	777 284	828 281					
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TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).

(Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	Separation of Biologicals	Preparation of Glasses	Supercool'q/Homoq. Nuclea.	Crystal Crowth/Solutions Composite Materials	Liquid Dispersions	Fluids Convection	OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Radio Engineer	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical	Physicist, Heat	Calibrator	Inspector Systems						
2005		PAYLC	MS-1(1) §	MS-2(1)		MS-2(3) (		MS-4(1) F	┢	┨	+	003.187	++	十	_	+	710 882	Н	Н	$\vdash$	+		+	+
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	Silicate Melt Susceptor Module Remover				I	$\mathbf{I}$		$\perp$	]		O.	$\rightarrow$	$\square$	I	I	Ι	L			$\Box$	I	$\prod$	$\perp$	I
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D	Silicate Melt Susceptor Operating Monitor		Н	N		1	22	20 X	1			Ñ	1	1	+		+		200	-	<u> </u>			+
	Zone Melter Control Actuator				1			$\triangle$	1		$\top$	8				T					工			
1406	Zone Melter Unstower	1				T			]		$\Box$	8	$\Box$	$\perp$	$\Box$	$\perp$	$\Gamma$			$\Box$	$\perp$	$\prod$	m I	
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1427	Zone Refiner Translocator		Ä	ं	ं		200 T					$\mathbf{X}$		y 3						$\prod$				
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TABLE 3-4:: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).

(Continued)

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CODE  TITLE    A		
CODE  TITLE    TOTAL		
1861   Densitometer Calibrator		
1862   Densitometer Operation Monitor		
1466   Densitometer Repairer		
1874   Calorimeter Repairer		
1480   Calorimeter Installer		
1481   Calorimeter Translocator   1482   Calorimeter Unstower   1483   Friction Measuring Device Repairer   1484   Friction Measuring Device Fault Identifier   1487   Friction Measuring Device Operation Monitor   1488   Friction Measuring Device Operation Monitor   1491   Friction Measuring Device Remover   1492   Friction Measuring Device Installer   1493   Friction Measuring Device Installer   1494   Friction Measuring Device Unstower   1495   Friction Measuring Device Unstower   1496   Friction Measuring Device Control Deactuator   1497   Friction Measuring Device Stower   1498   Friction Measuring Device Control Actuator   1498   Friction Measuring Device Cleaner   1499   Calorimeter Stower   1499   Calorimeter Stower   1500   Calorimeter Cleaner   1500   Calorimeter Cleaner   1500   Atmosphere Analysis Unit Control Deactuator   1507   Atmosphere Analysis Unit Control Deactuator   1508   Holographic Device Control Deactuator   1509   VHF Power Unit Control Deactuator   1512   Crystal Growth Process Monitor   1513   Glass Samples Unstower   1513   Glass Samples Unstower   1514   Crystal Growth Process Monitor   1515   Calorimeter Stower   1516   Calorimeter Stower   1517   Calorimeter Stower   1518   Calorimeter Stower   1519   Calorimeter Stower   1510   Calorimeter Stower   15110   Calorimeter Stower   1512   Calorimeter Stower   1513   Glass Samples Unstower   1514   Calorimeter Stower   1515   Calo		
1482 Calorimeter Unstower       △       △       △         1483 Friction Measuring Device Repairer       △       △       △         1484 Friction Measuring Device Operation Monitor       △       △       △         1487 Friction Measuring Device Operation Monitor       △       △       △         1488 Friction Measuring Device Calibrator       △       △       △         1491 Friction Measuring Device Remover       △       △       △         1492 Friction Measuring Device Installer       △       △       △         1493 Friction Measuring Device Unstower       △       △       △         1494 Friction Measuring Device Control Deactuator       △       △       △         1495 Friction Measuring Device Control Actuator       △       △       △         1496 Friction Measuring Device Stower       △       △       △         1497 Friction Measuring Device Control Actuator       △       △       △         1498 Friction Measuring Device Control Deactuator       △       △       △         1499 Calorimeter Stower       △       △       △       △         1500 Lation Measuring Device Control Deactuator       △       △       △       △         1500 Atmosphere Analysis Unit Control Deactuator       △		
1483   Friction Measuring Device Repairer		
1487   Friction Measuring Device Operation Monitor   1488   Friction Measuring Device Calibrator		
1488   Friction Measuring Device Calibrator   1491   Friction Measuring Device Remover   1492   Friction Measuring Device Installer   1493   Friction Measuring Device Installer   1494   Friction Measuring Device Unstower   1495   Friction Measuring Device Control Deactuator   1496   Friction Measuring Device Control Deactuator   1497   Friction Measuring Device Control Actuator   1498   Friction Measuring Device Cleaner   1499   Calorimeter Stower   1500   Calorimeter Cleaner   1505   Heating/Positioning Coil Control Deactuator   1507   Atmosphere Analysis Unit Control Deactuator   1508   Holographic Device Control Deactuator   1509   VHF Power Unit Control Deactuator   1512   Crystal Growth Process Monitor   1513   Glass Samples Unstower   1513   Glass Samples Unstower   1516   1516   1516   1517   1518   1	o X	
1491   Friction Measuring Device Remover   1492   Friction Measuring Device Installer   1493   Friction Measuring Device Translocator   1494   Friction Measuring Device Unstower   1495   Friction Measuring Device Control Deactuator   1496   Friction Measuring Device Control Actuator   1497   Friction Measuring Device Stower   1498   Friction Measuring Device Stower   1499   Calorimeter Stower   1500   Calorimeter Cleaner   1500   Calorimeter Cleaner   1500   Heating/Positioning Coil Control Deactuator   1507   Atmosphere Analysis Unit Control Deactuator   1508   Holographic Device Control Deactuator   1509   VHF Power Unit Control Deactuator   1512   Crystal Growth Process Monitor   1513   Glass Samples Unstower   1513   Glass Samples Unstower   1514   1515   1516		
1493       Friction Measuring Device Translocator         1494       Friction Measuring Device Unstower         1495       Friction Measuring Device Control Deactuator         1496       Friction Measuring Device Control Actuator         1497       Friction Measuring Device Stower         1498       Friction Measuring Device Cleaner         1499       Calorimeter Stower         1500       Calorimeter Cleaner         1505       Heating/Positioning Coil Control Deactuator         1508       Holographic Device Control Deactuator         1509       VHF Power Unit Control Deactuator         1512       Crystal Growth Process Monitor         1513       Glass Samples Unstower		117
1494       Friction Measuring Device Unstower         1495       Friction Measuring Device Control Deactuator         1496       Friction Measuring Device Control Actuator         1497       Friction Measuring Device Stower         1498       Friction Measuring Device Cleaner         1499       Calorimeter Stower         1500       Calorimeter Cleaner         1505       Heating/Positioning Coil Control Deactuator         1508       Holographic Device Control Deactuator         1509       VHF Power Unit Control Deactuator         1512       Crystal Growth Process Monitor         1513       Glass Samples Unstower		
1495       Friction Measuring Device Control Deactuator         1496       Friction Measuring Device Control Actuator         1497       Friction Measuring Device Stower         1498       Friction Measuring Device Cleaner         1499       Calorimeter Stower         1500       Calorimeter Cleaner         1505       Heating/Positioning Coil Control Deactuator         1508       Holographic Device Control Deactuator         1509       VHF Power Unit Control Deactuator         1512       Crystal Growth Process Monitor         1513       Glass Samples Unstower		+++
1496 Friction Measuring Device Control Actuator       □	<del>╎╎┞╏╏┩┪</del> ╸	+++
1497 Friction Measuring Device Stower       1498 Friction Measuring Device Cleaner       1499 Calorimeter. Stower       1500 Calorimeter Cleaner       1505 Heating/Positioning Coil Control Deactuator       1507 Atmosphere Analysis Unit Control Deactuator       1508 Holographic Device Control Deactuator       1509 VHF Power Unit Control Deactuator       1512 Crystal Growth Process Monitor       1513 Glass Samples Unstower	<del>╎╎╎╎</del> ┼┼┼┼┼	+++
1499 Calorimeter Stower  1500 Calorimeter Cleaner  1505 Heating/Positioning Coil Control Deactuator  1507 Atmosphere Analysis Unit Control Deactuator  1508 Holographic Device Control Deactuator  1509 VHF Power Unit Control Deactuator  1512 Crystal Growth Process Monitor  1513 Glass Samples Unstower   △ △ △ △ △ △ △ △ △ △ △ △ △ △ △ △ △ △		
1500 Calorimeter Cleaner  1505 Heating/Positioning Coil Control Deactuator  1507 Atmosphere Analysis Unit Control Deactuator  1508 Holographic Device Control Deactuator  1509 VHF Power Unit Control Deactuator  1512 Crystal Growth Process Monitor  1513 Glass Samples Unstower   □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □		
1505   Heating/Positioning Coil Control Deactuator		<del>1        </del>
1507   Atmosphere Analysis Unit Control Deactuator		111
1509 VHF Power Unit Control Deactuator		
1512 Crystal Growth Process Monitor  1513 Glass Samples Unstower	<del>                                     </del>	+++-
1513 Glass Samples Unstower	<del>┞┞</del> ┼┼┼┼┼	┼┼┼
1514 Glass Samples Translocator		
1515 Class Samples Installer  1516 Class Samples Remover		
1517 Glass Samples Stower		
1518 Class Structure Analyzer		
1519 Data Recorder Unstower 1520 Data Recorder Translocator		
1520 Data Recorder Translocator  1521 Glass Processing Research Planner		<del>                                     </del>
1522 Glass Processing Research Evaluator		
1524 Gas Elimination/Cooling System Installer		
1525 Gas Elimination/Cooling System Unstower  1526 Gas Elimination/Cooling System Translocator		<del>┧</del> ┪┪
1527 Gas Elimination/Cooling System Cleaner		111
1528 Cas Elimination/Cooling System Stower		
1529 Gas Elimination/Cooling System Operation Monitor		1 1 1
1534 Cas Elimination/Cooling System Fault Identifier		+++
1536 Cleanup/Refurbishment Equipment Installer		
1537 Cleanup/Refurbishment Equipment Unstower		177
1538 Cleanup/Refurbishment Equipment Translocator	<del>┈┼╂╌┠╌╏</del> ╌╏	+++
1539 Cleanup/Refurbishment Equipment Stower  1540 Buffer/Waste Separator Installer  □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □		<del>                                      </del>
1541 Buffer/Waste Separator Unstower		Ш
1542 Buffer/Waste Separator Translocator		
1543 Buffer/Waste Separator Cleaner		╁┼┼┼
1544 Buffer/Waste Separator Stower		

TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).

(Continued)

TASK - SKILL  TA	
1588   Buffer / Waste Separator Operation Monitor   1588   Buffer / Waste Separator Fault Identifier   1589   TV System Control Actuator   1530   Data Compression Equipment Centrol Actuator   1531   Buffer Solution Installer   1531   Buffer Solution Installer   1532   Buffer Solution Installer   1533   Buffer Solution Installer   1535   Buffer Solution Mixing Control   1535   Buffer Solution Remover   1536   Buffer Solution Rising Controller   1535   Buffer Solution Rising Controller   1535   Buffer Solution Mixing Controller   1535   Buffer Solution Mixing Controller   1535   Buffer Solution Mixing Controller   1536   Biological Materials Installer   1537   Biological Materials Translocator   1538   Biological Materials Remover   1538   Biological Enclosure Unstower   1538   Biological Enclosure Solwer   1538   Biological Enclosure Repairer   1538   Biological Enclosure Repairer   1538   Biological Enclosure Repairer   1537   Buffer / Waste Separator Repairer   1537   Electrophoretic Column Instower   1537   Electrophoretic Column Remover   1537   Electrophoretic Column Remover   1537   Electrophoretic Column Remover   1537   Electrophoretic Column Remover   1538   Electrophoretic Column Remover   1538   Electrophoretic Column Remover   1538   Electrophoretic Column Remover   1538   Electrophoretic Column Remover   1538   Electrophoretic Column Remover   1538   Electrophoretic Column Remover   1538   Electrophoretic Column Remover   1538   Electrophoretic Column Base Recorder   1538   Electrophoretic Column Base Recorder   1538   Electrophoretic Separation Process Evaluator   1538   Electrophoretic Column Base Recorder   1538   Electrophoretic Column Base Recorder   1538   Electrophoretic Column Base Recorder   1538   Electrophoretic Column Base Recorder   1538   Electrophoretic Column Base Recorder   1538   Electrophoretic Column Base Recorder   1538   Electrophoretic Column Base Recorder   1538   Electrophoretic Column Base Recorder   1538   Electrophoretic Column Base Recorder   1538   1538   1538   1538	
1588   Tuffer Waste Separator Fault Identifier   1591   Tuffer Solution   National Actustor   1592   Tuffer Solution   National Actustor   1591   Buffer Solution   National Actustor   1591   Buffer Solution   National Actustor   1592   Buffer Solution   National Actustor   1593   Buffer Solution   National Actustor   1594   Buffer Solution   National Actustor   1595   Buffer Solution   Mixing Controller   1595   Buffer Solution   Mixing Controller   1595   Buffer Solution   Mixing Controller   1595   Bufogical Materials   Installer   1595   Biological Materials   Installer   1595   Biological Materials   Installer   1595   Biological Materials   Installer   1595   Biological Materials   Installer   1595   Biological Materials   Installer   1595   Biological Enclosure   Installer   1596   Biological Enclosure   Installer   1597   Biological Enclosure   Installer   1598   Biological Enclosure   Installer   1597   Biological Enclosure   Installer   1597   Electrophoretic Column   Installer   1597   Electrophoretic Column   Installer   1597   Electrophoretic Column   Installer   1597   Electrophoretic Column   Installer   1597   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1597   Electrophoretic Column   Installer   1597   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Electrophoretic Column   Installer   1598   Installer   1598   Installer   1598   Installer   1598   Installer   1598   Installer   1598   Installer   1598   Installer   1598   Installer   1598   Installer   1598   Installer   1598   Install	
1589   Data Compression Equipment Control Actuator	
1550   Data Compression Equipment Control Actuator	
1552   Buffer Solution Translocator	
1553   Buffer Solution Translocator	
1555   Buffer Solution Remover	
1555   Buffer Solution Mixing Controller	
1558   Biological Materials Translocator	
1558   Biological Materials Translocator	
1559   Biological Materials Remover	
1562   Biological Enclosure Stower	
1563   Biological Enclosure Operation Monitor	
1568   Biological Enclosure Fault Identifier	+++
1572   Buffer/Waste Separator Repairer   1573   Flectrophoretic Column Installer   1574   Flectrophoretic Column Unstower   1575   Electrophoretic Column Remover   1575   Electrophoretic Column Remover   1576   Flectrophoretic Column Cleaner   1577   Electrophoretic Column Stower   1578   Electrophoretic Column Stower   1578   Electrophoretic Column Departion Monitor   1584   Electrophoretic Column Fault Identifier   1585   Electrophoretic Column Repairer   1586   Electrophoretic Separation Research Planner   1587   Electrophoretic Separation Process Evaluator   1588   Electrophoretic Separation Process Evaluator   1588   Electrophoretic Separation Process Evaluator   1589   Lyophilization Apparatus Control Actuator   1589   Lyophilization Apparatus Control Actuator   1593   Ampoule Installer   1601   Interferometer Unstower   1602   Interferometer Unstower   1603   Interferometer Remover   1604   Interferometer Remover   1605   Interferometer Calibrator   1607   Interferometer Stower   1608   Interferometer Stower   1609   Interferometer Controller   1609   Interferometer Controller   1609   Interferometer Controller   1609   Interferometer Controller   1609   Interferometer Gontroller	
1573   Electrophoretic Column Installer	
Section   Sect	╅┼┦┦
1575   Electrophoretic Column Translocator   1576   Electrophoretic Column Remover   1577   Electrophoretic Column Cleaner   1578   Electrophoretic Column Stower   1579   Electrophoretic Column Operation Monitor   1584   Electrophoretic Column Repairer   1585   Electrophoretic Column Repairer   1586   Electrophoretic Separation Research Planner   1587   Electrophoretic Separation Process Evaluator   1588   Electrophoretic Separation Data Recorder   1589   Electrophoretic Separation Data Recorder   1589   Electrophoretic Separation Data Recorder   1589   Electrophoretic Separation Data Recorder   1589   Electrophoretic Separation Data Recorder   1589   Electrophoretic Separation Data Recorder   1580   Interferometer Installer   1601   Interferometer Installer   1602   Interferometer Unstower   1603   Interferometer Calibrator   1604   Interferometer Calibrator   1606   Interferometer Calibrator   1606   Interferometer Calibrator   1606   Interferometer Tester   1607   Interferometer Stower   1608   Interferometer Stower   1609   Interfer	
1577   Electrophoretic Column Cleaner	
1578   Electrophoretic Column Stower   1579   Electrophoretic Column Operation Monitor   1584   Electrophoretic Column Fault Identifier   1585   Electrophoretic Column Repairer   1586   Electrophoretic Separation Research Planner   1587   Electrophoretic Separation Process Evaluator   1588   Electrophoretic Separation Data Recorder   1589   Lyophilization Apparatus Control Actuator   1598   Ampoute Installer   1598   Ampoute Installer   1602   Interferometer Unstower   1603   Interferometer Unstower   1604   Interferometer Remover   1605   Interferometer Calibrator   1606   Interferometer Calibrator   1606   Interferometer Tester   1607   Interferometer Stower   1608   Interferometer Controller   1609   Interferometer Controller   1609   Interferometer Controller   1609   Interferometer Controller   1609   Interferometer Controller   1609   Interferometer Controller   1609   Interferometer Fault Identifier   1609   Interfer	3 5 2
1579   Electrophoretic Column Operation Monitor   1584   Electrophoretic Column Fault Identifier   1585   Electrophoretic Column Repairer   1586   Electrophoretic Separation Process Evaluator   1587   Electrophoretic Separation Process Evaluator   1588   Electrophoretic Separation Data Recorder   1589   Lyophilization Apparatus Control Actuator   1598   Ampoute Installer   1601   Interferometer Installer   1602   Interferometer Unstower   1603   Interferometer Translocator   1604   Interferometer Remover   1605   Interferometer Calibrator   1606   Interferometer Tester   1607   Interferometer Tester   1608   Interferometer Controller   1609   Interferometer Controller	
1586   Electrophoretic Separation Research Planner   1587   Electrophoretic Separation Process Evaluator   1588   Electrophoretic Separation Data Recorder   1589   Expephilization Apparatus Control Actuator   1598   Ampoule Installer   1601   Interferometer Installer   1602   Interferometer Unstower   1603   Interferometer Remover   1604   Interferometer Remover   1605   Interferometer Calibrator   1606   Interferometer Tester   1607   Interferometer Stower   1608   Interferometer Controller   1609   Interferometer Controller   1619   Interferometer Fault Identifier   1615   Interferometer Fault Identifier   1615   Interferometer Repairer   1615   Interferometer Repairer   1616   Interferometer Repairer   1617   Interferometer Repairer   1618   Interferometer Repairer   1618   Interferometer Repairer   1618   Interferometer Repairer   1619   In	
1586   Electrophoretic Separation Research Planner   1587   Electrophoretic Separation Process Evaluator   1588   Electrophoretic Separation Data Recorder   1589   Expephilization Apparatus Control Actuator   1598   Ampoule Installer   1601   Interferometer Installer   1602   Interferometer Unstower   1603   Interferometer Remover   1604   Interferometer Remover   1605   Interferometer Calibrator   1606   Interferometer Tester   1607   Interferometer Stower   1608   Interferometer Controller   1609   Interferometer Controller   1619   Interferometer Fault Identifier   1615   Interferometer Fault Identifier   1615   Interferometer Repairer   1615   Interferometer Repairer   1616   Interferometer Repairer   1617   Interferometer Repairer   1618   Interferometer Repairer   1618   Interferometer Repairer   1618   Interferometer Repairer   1619   In	4444
1587   Electrophoretic Separation Process Evaluator   1588   Electrophoretic Separation Data Recorder   1589   Eyophilization Apparatus Control Actuator   1598   Ampoule Installer   1598   Ampoule Installer   1601   Interferometer Installer   1602   Interferometer Unstower   1603   Interferometer Translocator   1604   Interferometer Remover   1605   Interferometer Calibrator   1606   Interferometer Tester   1607   Interferometer Stower   1608   Interferometer Controller   1609   Interferometer Operation Monitor   1614   Interferometer Fault Identifier   1615   Interferometer Repairer   1615   Interferometer Repairer   1615   Interferometer Repairer   1615   Interferometer Repairer   1615   Interferometer Repairer   1615   Interferometer Repairer   1616	++++
1588   Electrophoretic Separation Data Recorder   1589   Lyophilization Apparatus Control Actuator   1598   Ampoule Installer   1601   Interferometer Installer   1602   Interferometer Unstower   1603   Interferometer Translocator   1604   Interferometer Remover   1605   Interferometer Calibrator   1606   Interferometer Tester   1607   Interferometer Stower   1608   Interferometer Controller   1609   Interferometer Controller   1619   Interferometer Fault Identifier   1615   Interferometer Facility Interferometer Repairer   1615   Interferometer Repairer   1615   Interferometer Repairer   1615   Interferometer Repairer   1615   Interferometer Repairer   1615   Interferometer Repairer   1615   Interferometer Repairer   1615   Interferometer Repairer   1616   1616   Interferometer Repairer   1617   Interferometer Repairer   1618   Interferometer R	++++
1598   Ampoute Installer	
1601   Interferometer Installer	25   10   1   12   25   25   3   3   3
1602   Interferometer Unstower	
1603   Interferometer Translocator	900
1607   Interferometer Stower	
1607 Interferometer Stower 1608 Interferometer Controller 1609 Interferometer Operation Monitor 1614 Interferometer Fault Identifier 1615 Interferometer Repairer  □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□	<del>-}-}-</del> }
1607 Interferometer Stower 1608 Interferometer Controller 1609 Interferometer Operation Monitor 1614 Interferometer Fault Identifier 1615 Interferometer Repairer  □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□	<del>+++</del>
1609   Interferometer Operation Monitor	
1619 Interferometer Fault Identifier	<u> </u>
16ts  Interferometer Repairer	*
1616 Interferometer Control Actuator  1617 Densitometer Control Actuator  1618 Densitometer Tester  1619 Densitometer Stower	
1617 Densitometer Control Actuator 1618 Densitometer Tester 1619 Densitometer Stower	4444
1619 Densitometer Stower	╅╅┪┪
1620 Densitometer Controller	444
1621 Buffer/Waste Separator Remover	┼┼┼┤
1622 Gas Elimínation/Cooling System Remover	<del></del>
1624 Biological Materials Test Observer	
	4444
1626 Biological Materials Mixing Controller	4444

TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).

(Continued)

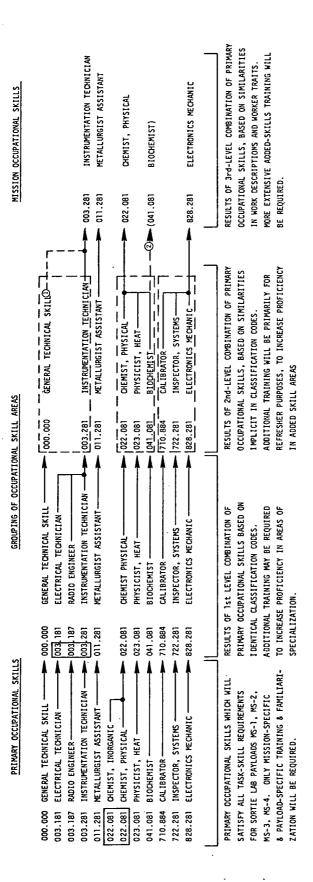
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	TASK - SKILL	PAYLOADS/EXPERIMENTS	Separation of Biologicals	Preparation of Classes	Supercool'g/Homog. Nuclea	Crystal Growth/Solutions	Lomposite Materials	Fluids Convection	Crystal Growth/Melts	OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Radio Engineer	Metallurgist Assistant	Chemist, Inordanic	Chemist, Physical	Physicist, Heat	Biochemist @	Calibrator	Inspector, Systems	Electronics Mechanic					
CODE	TITLE	PAY	MS-1(1)	MS-2(1)	MS-2(2)	MS-2(3)	MS-3(1)	MS-4(1)	MS-4(2)	CODE	000.000	003.181	003.187	003.281	022.081	022.081	023.081	041.081	710.884		828.281					
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	Fluid Convection Research Evaluator Fluid Samples Installer							$\overline{\lambda}$					k	5		100	۲						1			
	Fluid Samples Translocator						d	K			O	Ħ		ঠ						T.		1		ď	T i	
1652	Fluid Samples Unstower	1					$\perp$	Z	1					<u> </u>	Γ		L			I	T	Ι	L			Ι
	Fluid Samples Remover			Ц	آپ	J	_[_	Ā	$\Box$		П	_[		<b>A</b>	L			Ц	$\Box$	Ţ	Ţ	I	$\bot$		Ţ	$\perp$
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****	Instrumentation & Control Center Fault Identifier		$\triangle$	<u> </u>	4	$\triangle$	Δ.	L								×.					2			)	<u>                                     </u>	
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	Accident Control System Control Actuator  Viewing Device Control Actuator	Sec.	Н	汁		7		4	Н	2000 <b>(</b>	300			¥	<u> </u>	288		-		+	-	4-		~ 12	+	Н
	Glass Processing Research Monitor		H	⋛	-*	7	+-	t	┧	ł	+	+		<b>ð</b> -	H	$\exists$	$\vdash$	+	$\dashv$	+	+	+	$\Box$	+	+	H
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2260	Accident Control System Repairer  Materials Analysis Equipment Inspector		Н	χŀ	4	$^{\prime\prime}$	₩	长	宗		<del>a f</del>		· la	+	Н	4	-1	-+	1	1/2	4-	+	+	+		H
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TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).

(Continued)

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		PAY	MS-1(1)	MS-2(1)	MS-2(2)	MS-2(3)	MS-3(2)	MS-4(1)	NS-4(2)	2000	003 181	003.187	003.281	022.081	022.081	023.081	041.081	710.884	2.281	187.878					T
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BOTH PRIMARY OCCUPATIONAL SKILLS. WHEN THE BIOLOGICAL EXPERIMENTS ARE ORBITED WITHOUT THE OTHER MATERIAL EXPERI-© ASSIGNMENT OF 041.081, BIOCHEMIST, TO 022.081, PHYSICAL CHEMIST, IS APPLICABLE ONLY FOR MISSIONS WHICH REQUIRE MENTS, THE APPROPRIATE MISSION OCCUPATIONAL SKILL IS 041.081, BIOCHEMIST. DASSIGNMENT OF 000.000, GENERAL TECHNICAL SKILL, TO PRIMARILY ON CONCURRENT REQUIREMENTS. OTHER 3rd-LEVEL SKILLS COULD SATISFY THE SKILL REQUIREMENT 003.281, INSTRUMENTATION TECHNICIAN, IS BASED WITH EQUAL EASE.

Derivation of Mission Occupational Skills for Sortie Lab Material Sciences Payloads MS-1, MS-2, MS-3, and MS-4 Figure 3-4:



## 3.3.3.2.2 Supercooling and Homogeneous Nucleation (MS-2(2))

Analysis of this experiment resulted in the identification of 224 different task-skill titles which were correlated to nine (9) different occupational skills. As explained in paragraph 3.3.3.2.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively, along with other MS payload data.

## 3.3.3.2.3 Crystal Growth from Solutions (MS-2(3))

Analysis of this experiment resulted in the identification of 157 different task-skill titles which were correlated to eight (8) different occupational skills. As explained in paragraph 3.3.3.2.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively, along with other MS payload data.

#### 3.3.3.2.4 Levitation Experiments Combined (MS-2)

Analysis of all experiments in this payload resulted in the identification of 285 different task-skill titles which were correlated to nine (9) different occupational skills. As explained in paragraph 3.3.3.2.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively. The skill grouping methodology is described in Section 2.2. The analysis of the three experiments in this payload leads to the conclusion that all the tasks required by the experiments can be accomplished by a crew-complement with the following Occupational Skills:

#003.281 Instrumentation Technician #011.281 Metallurgist Assistant #022.081 Chemist, Physical #828.281 Electronics Mechanic

As noted in Figure 3-4, some cross-training will be required to adequately reflect the Primary Occupational Skills in the selected Mission Occupational Skills. Also, as previously discussed, this listing is for a complement of occupational skills and does not necessarily represent a crew of four individuals.

## 3.3.3.3 Furnace Experiments (MS-3)

Experiments included in this payload, according to Sortie Lab references, were:

- (1) Composite Materials
- (2) Directional Solidification

Although the "Composite Materials" experiment was easily identified, and previously described (Ref. 6), there was no previously described experiment under the title of "Directional Solidification". A comparison of apparent requirements, implicit in the title, led to the selection of a documented experiment which would be suitable for purposes of task and skill requirements



analyses. As a result, the two experiments analyzed for this payload were:

- (1) Metallurgical Processes: Composite Materials
- (2) Metallurgical Processes: Liquid Dispersions

## 3.3.3.3.1 Composite Materials (MS-3(1))

Analysis of this experiment resulted in the identification of 130 different task-skill titles which were correlated to seven (7) different occupational skills. Payload MS-3(1) task-skills and their respective primary occupational skills are listed in Table 3-4, together with the primary and mission occupational skills for other MS payloads. The derivation of these skill groupings, which was accomplished at the total payload (MS-3) level, is illustrated in Figure 3-4.

## 3.3.3.3.2 Liquid Dispersions (MS-3(2))

Analysis of this experiment resulted in the identification of 166 different task-skill titles which were correlated to seven (7) different occupational skills. As explained in paragraph 3.3.3.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively, along with other MS payload data.

## 3.3.3.3 Furnace Experiments Combined (MS-3)

Analysis of the two experiments in this payload resulted in the identification of 209 different task-skill titles which were correlated to eight (8) different occupational skills. As explained in paragraph 3.3.3.3.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively. The skill-grouping methodology is described in Section 2.2. The conclusion reached as a result of these analyses is that all MS-3 payload tasks can be accomplished by a crew complement with the following Occupational Skills:

#003.281 Instrumentation Technician

#011.281 Metallurgist Assistant

#828.281 Electronics Mechanic

As noted in Figure 3-4, some cross-training will be required to adequately reflect the Primary Occupational Skills in the selected Mission Occupational Skills. Also, as previously discussed, this listing is for a complement of occupational skills and does not necessarily represent a crew of three individuals.

## 3.3.3.4 Small and Low Temperature Experiments (MS-4)

Experiments included in this payload, according to Sortie Lab references, were:

- (1) Physics of Fluids
- (2) Zone Refining



Comparison of apparent requirements, implicit in the experiment titles, led to selection of two previously described experiments which were judged suitable for purposes of task and skill requirements analysis. These experiments were:

- (1) Physical Properties of Fluids: Convection
- (2) Crystal Growth: Single Crystal Growth from Melts

## 3.3.3.4.1 Fluid Convection (MS-4(1))

Analysis of this experiment resulted in the identification of 138 different task-skill titles which were correlated to nine (9) different occupational skills. Payload MS-4(1) task-skills and their respective primary occupational skills are listed in Table 3-4, together with the primary and mission occupational skills for other MS payloads. The derivation of these skill groupings, which was accomplished at the total payload (MS-4) level, is illustrated in Figure 3-4.

## 3.3.3.4.2 Crystal Growth from Melts (MS-4(2))

Analysis of this experiment resulted in the identification of 164 different task-skill titles which were correlated to eight (8) different occupational skills. As explained in paragraph 3.3.3.4.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively, along with other MS payload data.

## 3.3.3.4.3 Small/Low Temperature Experiments Combined (MS-4)

Analysis of the two experiments in this payload resulted in the identification of 226 different task-skill titles which were correlated to ten (10) different occupational skills. As explained in paragraph 3.3.3.4.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively. The skill grouping methodology is described in Section 2.2. Subsequent to combining the results of the separate experiments in this payload, it has been concluded that all MS-4 experiment tasks can be accomplished by a crew complement with the following Occupational Skills:

#003.281 Instrumentation Technician #022.081 Chemist, Physical #828.281 Electronics Mechanic

As noted in Figure 3-4, some cross-training will be required to adequately reflect the Primary Occupational Skills in the selected Mission Occupational Skills. Also, as previously discussed, this listing is for a complement of occupational skills and does not necessarily represent a crew of three individuals.

# 3.3.3.5 Multiexperiment Materials Sciences Payloads

Although the task and skills analyses for the encompassed Materials Sciences payloads were accomplished at the designated payload (by experiment) level, it is quite

# 

possible that a specific Materials Sciences mission will include more than one of the separate payloads. Thus, MS-1 and MS-3 may be orbited together, as may be any other combination of the four payloads (MS-1, MS-2, MS-3, MS-4). It is also possible that one or more of the MS payloads may be joined by one or more compatible payloads from other MS research areas, or even from other disciplines (e.g., Astronomy, Physics, etc.). Assuming that combinations of payloads MS-1, MS-2, MS-3, and MS-4 were feasible, based on parameters other than skills, a determination was made of the extent of skill commonality with these payloads in various combinations. As can be seen from examination of Table 3-4, task-skill commonality is significant across experiments and payloads, especially when the primary task dependency (from which the task-skill is derived) is an equipment interface. Commonality is lower in those task-skills where a specific area of knowledge is the determinant, but still occurs frequently.

Even more significant, as is shown in Table 3-5, even though the number of required task-skills for the four payloads combined increases to 564, the number of Primary Occupational Skills only increases to a maximum of twelve (12), all of which can be grouped into four Mission Occupational Skills:

#003.281 Instrumentation Technician #011.281 Metallurgist Assistant #022.081 Chemist, Physical #828.281 Electronics Mechanic

These, of course, are the same four Mission Occupational Skills required for payload MS-2 alone. The obvious conclusion to be reached, in terms of skill requirements, is that payload MS-2 should be the nucleus of any recombinations of Materials Sciences payloads into a new payload. It should also be pointed out, as noted in Figure 3-4, that Occupational Skill #041.081, Biochemist, is the MOS of choice only for MS-1 payloads alone or when skill #022.081, Physical Chemist, is not required by the payload experiment.

Cross-training requirements obviously will be greatly increased in order to accommodate all task-skill requirements in these multiple payloads. There is little additional impact on skill requirements when a multiple payload with two of the original payloads is increased to accommodate three or all four payloads. This is especially true if one of the two initial payloads is MS-2, Levitation Experiments.

A further possibility is that specific experiments within the designated payloads may be combined in a different manner to make up a different payload. While this is recognized as possible, the effect on combinations of skills was not specifically explored. This data can be determined, however, from the listings in Table 3-4.

### 3.3.4 Materials Sciences Payloads Skills Summary

The data which has resulted from the skills analysis make it quite apparent that availability of the Occupational Skills required on orbit should present no major problem insofar as the MS payloads encompassed by this study are concerned. This should be true whether the payloads are orbited individually



TABLE 3-5: Comparison of Single Experiment-Area Payloads to Multiple Experiment-Area Payloads, MS Missions.

P	AYL	JA0	)S	Number of	Number of	Number of
MS - 1	MS - 2	MS - 3	MS - 4	Number of Task Skills	Preliminary Occupational Skills ①	Mission Occupational Skills
Х				118	8	3
	Х			285	9	4
		χ		209	8	3
			Χ	226	10	3
Х	χ			375	10	4 ②
Х		Χ		300	9	4
Χ			Χ	311	11	3 ②
	Χ	X		367	9	4
	Χ		χ	370 '	11	4
		χ	χ	309	11	4
Х	Χ	χ		453	10	4 ②
Χ	χ		Χ	449	12	4②
Х		Χ	Х	388	12	4 ②
	Χ	X	Х	418	11	4
Х	Χ	Χ	Х	495	12	4 ②

- (1) Film Developer, 976.782, is not included; see paragraph 3.3.1
- (2) When other payloads are in combination with MS-1, #022.081, Physical Chemist (when available) can satisfy requirements for #041.081, Biochemist. See Figure 3-4.

or in combination. In addition, indications are favorable that other Materials Sciences payloads could be added without severely constraining the availability of needed skills. The question which cannot yet be answered, though, is whether the number of needed skills can be appropriately matched with the numerical crew complement. This, of course, will be dependent on factors such as permissible crew size, total workload, simultaneous tasks, etc. Nevertheless, advance planning and study can proceed with confidence that availability of the identified Mission Occupational Skills should be adequate to accomplish all predicted tasks for these Materials Sciences and Manufacturing missions without long-lead time, specialized training.



# 3.4 General Summary of Skill Requirements Analyses

The skill analyses conducted under this contract have included seven payloads in two entirely different research areas, comprising eleven separate experiments. Collectively, this has resulted in the identification of 819 task-skills which can be expected to be required during the conduct of these missions. Twenty one (21) different Primary Occupational Skills were identified which can satisfy the requirements of all of the designated task-skills, and these, in turn, can be grouped into five (5) Mission Occupational Skills. Because of the disparity between research objectives, gravity constraints, etc., of the two research areas, it is unlikely that any Sortie Lab mission would attempt combinations of Earth Observations and Materials Sciences payloads, although this could become a reality in the more distant Space Station program.

The composite of all task-skills identified in support of this study, together with the related payloads, Primary Occupational Skills, and Mission Occupational Skills, is presented in Table 3-6 for reference. A total listing of task-skills identified to date (NASw-2192; NAS8-28359) is included as Appendix E to this report. A composite list of Task Dependencies, used in deriving the Task-Skills, is included as Appendix D. Definitions and descriptions of each identified Occupational Skill, extracted from References 20 and 21, are included as Appendix F.



TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.

Title				_	<del>,</del> .	,	_	_	_	_		_		_	_	_		_										•
Title		TASK - SKILL	YLOADS / EXPERIMENTS	r & Water Pollution	sources Recognition	saster Assessment	ological Experiments	vitation Experiments	irnace Experiments	nall/Low Temperature Exp.		OCCUPATIONAL SKILLS	Radio Engineer	Systems Engineer EDP	Instrumentation Technician	Optical Technician	Metallurgist Assistant	Surveyor, Geodetic	Chemist, Inorganic	Chemist, Physical	Physicist, Heat	Geophysicist	Meteorologist	Weather Observer	Biochemist	Calibrator	camera Inspector	Electronics Mechanic
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10268   TV Mode Selector   10271   Camera Mode Selector   10272   Camera Mode Selector   10292   Camera Unstower   10294   Camera Inspector   10297   Telescope Aligner   10297   Telescope Unstower   10297   Telescope Unstower   10297   Telescope Unstower   10297   Telescope Unstower   10297   Telescope Unstower   10297   Telescope Unstower   10297   Telescope Control Deactuator   10297   Telescope Contr			1	$\stackrel{()}{\triangleright}$	$\mathbb{R}$	$\Delta$	Н	Н	+	+	4	(	-	╀	$\stackrel{\wedge}{\rightarrow}$	$\dashv$	4	-	+	+	+		<u> </u>	щ	4		┼-	₩
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10397   Telescope Aligner   10303   Telescope Unstower   10306   TV Camera Installer   10314   Camera Remover   10320   Telescope Control Deactuator   10320   Telescope Control Deactuator   10320   Telescope Control Deactuator   10334   TV Camera Controller   10334   TV Camera Controller   10335   Camera Controller   10336   Spectrometer Controller   10337   Telescope Controller   10337   Telescope Controller   10337   Telescope Controller   10337   Telescope Controller   10339   TV System Module Remover   10339   TV System Module Installer   10339   Tolescope Controller   10339	0292	Camera Unstower				À		4	分	A	1	ို			Ø	4		្ប	<b>I</b>						ा	1	Ę	
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D516   Meteorological Condition Observer   D519   Computer Module Remover   D520   Computer Module Installer   D520   D	393	Calorimeter Control Deactuator	3			二		Δ		1	]					1	1	#	1	Ţ	I				$\Box$	I		口
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<sup>&</sup>lt;sup>1</sup>General Technical Skill, 000,000, Assigned. <sup>2</sup>Special Spaceflight Skill, XXX.XXX, Assigned. Table 3-6, p. 1 of 15

\*No Occupational Skill Assigned; see text, paragraph 3.2.1

© The skill listings for each payload, individually

<sup>\*\*</sup>No Mission Occupational Skill Assigned; see text and Figure 3-2

<sup>6</sup> The skill listings for each payload, individually, are included in Appendix C.



TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills. (Continued)

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	TASK - SKILL	PAYLOADS/EXPERIMENTS	Air & Water Pollution		EO-5 Disaster Assessment	Biological Experiments	MS-2 Levitation Experiments	Furnace Experiments	MS-4 Small/Low Temperature Exp.	311123 1411014 1411000	OCCUPATIONAL SKILLS	Radio Engineer	Systems Engineer EDP	Instrumentation Technician	Optical Technician	Metallurgist Assistant	Surveyor, Geodetic	Chemist, Inorganic	Chemist, Physical	Physicist, Heat	Geophysicist	Meteorologist	Weather Observer	Biochemist	Calibrator	Presente Contour	Electronics Mechanic
•		Æ		•				-3 Fu	-4 Sm	1000		187	187	003, 281	007,081	011,281	018.188	022.081	022,081	023.081	024.081	025.088	025.288	041.081	710.884	722 281	281
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0615	Radar Transmitter Module Remover			Ķ	$\triangle$						Ţ	7		X				4			1						E
0616 0623	Radar Transmitter Module Installer Radar Receiver Module Installer		-	$\forall$	$\stackrel{()}{\succ}$	$\dashv$	$\dashv$	-	+	-	F	4	+	₩	$\dashv$	+	4	+	+	+	+	-	$\vdash$	Н	+	+	+
0624	Radar Receiver Module Remover		H			Н	+	+	+	1	È	#	t	夂	$\dashv$	+	+	+	+	+	+	t	$\vdash$	H	+	+	+-
0627	Radar Receiver Tester		F		Ž		$\exists$	1	#	]	Č	1		X	$\Box$	$\exists$	コ	$\perp$		$\top$	I				#	Ţ	I
0628 0633	Radar Transmitter Unstower TV Camera Tester		-					A.	χŀ	1	þ	7	+	Ø		1		8.0	X   3		1-	100	20				100
0637	Radiometer Module Installer		$\triangle$		$\triangle$		Ħ	Ť		1	t	1		X			1			+	13	1				1	1
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0653	Polarimeter Mode Monitor			$\bigcirc$			$\Box$			1		I		Ø	$\Box$	1		1	$\perp$	I	匚						L
0661 0662	TV Camera Remover		<u> </u>	H	Н	4	$\stackrel{\mathcal{A}}{\leftrightarrow}$	¥	<del>) </del>	1	C	4	╀	$\boxtimes$	4	4	$\dashv$	+	4	$\perp$	╀-	L	$  \cdot  $	$\dashv$		$\downarrow$	igdash
0664	Telemetry Equipment Control Actuator  Radar Transmitter Control Deactuator		-	M	H	$\dashv$	4	+	4	┨	+	+	╁		$\dashv$	+	+	+	╁	+	+-		Н	-	+	+	╁
0666	Radar Receiver Control Deactuator				$\triangle$		30			18	E			$\boxtimes$							le:		3				
0672	TV Camera Control Deactuator		$\stackrel{\wedge}{\sim}$		X		្ឋ							$\otimes$	4		4			1	1	20					
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0684				Ā	$\overline{\mathbf{X}}$			1		7	T					1	1	+							7		核
0685	Radar Receiver Fault Identifier		L	Ž	Ž	$\exists$	7	1	1	]		I		П	$\exists$	T	$\exists$	1	Ţ	T	$\perp$			$\exists$	$\perp$	L	$\overline{\mathbb{Q}}$
0686	Radar Receiver Repairer	1	$\vdash$	$\Box$	$\stackrel{\triangle}{=}$	$^{\prime}$	$\frac{1}{2}$	XI.	+	┨	-	╀	-	U	$\dashv$	+	4	+	+	+	╁╌	Н	$\vdash$	+	+	╁	急
0690	TV Camera Fault Identifier TV Camera Repairer			Н			$\overrightarrow{A}$	∜	4	1	$\vdash$	+	├-	Н	4	+	+	+	╁	+	+	Н	$\vdash$	$\dashv$	+	┿	微
0691	Radiometer Fault Identifier		$\triangle$	$\triangle$	$\triangle$			Ī		1		工				I		1	I							Í	$\boxtimes$
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	Electronic Equipment Fault Identifier		8.5	$\triangle$	$\Delta$					1				$\otimes$													
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	Polarimeter Control Actuator	100		 	٦	+	_	4	+	1**	× -	T		X	1	۲	7	†	1	Ť			_	Ĵ	$\perp$	T	Н
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[n- ·	Primary Occupational Skill. $\overline{X}$ = Mission Occupational Sk	ill		ŹΊ	-			٠.	:11									_			ent						



TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

	TASK - SKILL	PAYLOADS / EXPERIMENTS	Air & Water Pollution		EU-5 Disaster Assessment MC-1 Riological Experiments	Levitation Experiments			DE OCCUPATIONAL SKILLS	Flectrical Technici	╁╴	H	+	$\dagger$	+	84   Chemist Inorganic	╁		$\dashv$	+	88 Weather Observer	+	-	+	81   Electronics Mechanic
			E0-3	E0-4	10-12 MA-12-12	MS-2	MS-3	MS-4	CODE	003 181	003, 187	003.187	003,281	007.081	011, 281	072 081	022 081	023.081	024.081	024.081	025.088	041.081	710.884	722 281	828.281
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0874	Telescope Operation Evaluator								1				SI.											1	1
0875 0876	Camera Operation Evaluator Scanner Operation Evaluator		K		<u> </u>		M		4						4	40	1			4	4			4	42
0877	Radiometer Operation Evaluator			士	1	I		士	1				8	士	士	士	T			士	士	H		士	士
0879	Spectrometer Operation Evaluator			1	$\bot$				7	L	L		Ø	1	1	Ļ	Ļ		J	$\bot$	T	П		Ŧ	Ţ
0880 0882	Polarimeter Operation Evaluator Sferics Detector Data Quality Monitor		1	1	4	╁	Н	+	┨	$\vdash$	+-	H		+	+	+	╀	Н	+	+	+	Н	+	+	十
0884	Scanner Optics Cleaner				<u>Z</u> :	12	<i>.</i>	<i>3</i>			8		ă			10	12	8		1			ŵ. }		13
CONTRACTOR OF THE	Telescope Fault Identifier		$\Box$	$\mathbb{H}$	48	<del> </del>	$\lambda$		4	-		$\Box$	$\mathfrak{A}$	읶.		12	1		4		1		4. P		K
0886 0887	Camera Fault Identifier Scanner Fault Identifier		X	<del> </del>	+		+	_	$\exists$				4	1					4	#	+	Н	800 T		*
	Scatterometer Fault Identifier	Ŕ		,				4% V	]			Š		ं						13			28.		
0889	Polarimeter Fault Identifier	ĺ	岸	4	╀	╀	Н		4	$\vdash$	Н	-	+	- -	+	+	<del> </del> -	Н	4	+	╀	Н	-	+	<u> </u>
0890 0891	Sferics Detector Fault Identifier Optical Equipment Fault Identifier			ΔŽ	1	╁	Н		1	-	Н	-	xk	ᢐ	+	+	┞	Н	$\dagger$	$\dagger$	+	Н	$\dashv$	十	緣
0895	Telescope Presentation Observer			ΔŽ	7	L			1					1	1	1			Š	1	$\perp$		$\exists$	丰	Ī
0896 0897	TV Presentation Observer	22	$\Theta$	Λ <u>/</u>	<del>\</del>	1 24	- 27		100		1381	300	\$30 B	1		-			7 () 7 ()	針	+			1	
0898	Scanner Presentation Observer Radiometer Presentation Observer			7/2	1	Å							× .						Ò	<b>1</b>	+		X I	12	1
0899	TV Camera Control Actuator			Ž	1	$\triangle$	Δ	$\Delta$	7		25		S	. 8			100	33. 33.		I	$\top$			I	I
0904	Scanner Module Remover Scanner Module Installer	<i>X</i>	X	#	7	1		33 ( 33 (4)	-	1			҈			4 A 3 A S	(2) (2)	337			+	$\vdash$	78 () 8 ()		
	Polarimeter Module Remover									Ŏ			X		I				1	$\perp$				Ι	Ï
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	Polarimeter Presentation Observer Spectrometer Presentation Observer		Ħ	オ	╁	╁	Н	+	┨	$\vdash$	Н	$\dashv$	+	+	╁	╁	╁╌	$\vdash$	- 18	₹-	╁	$\vdash$	+	+	╁
0916	Scanner Mode Selector		$\triangle$	<u> </u>	7				1	D			X	士	T				Ž	1				I	上
	Radiometer Mode Selector		兴	$\mathbb{A}$	4			4/2	4	Ç		**	<b>4</b>		6 28 0 28	18	13 - 1 20	8	12	3	98			40	1
0919	Polarimeter Mode Selector Polarimeter Control Deactuator			∜			8		-	2		* (	8						<u> </u>	1				1	+
0921	Telescope Pointing Controller **	¥7.		Z	1				] 2											I					
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	Radiometer Optics Cleaner	•		$\Delta Z$	$\perp$			$\top$	1				8	1		T				土			士	土	İ
	Polarimeter Optics Cleaner	1	Ŵ	$\Delta$		Ц		$\perp$	]		П	_(	<u> </u>	1	L			П	4	T	П	$\Box$	1	1	5
	Earth Survey C/D Equipment Module Remover Earth Survey C/D Equipment Module Installer	1	$\mathbb{R}^{2}$	$\forall$	+	Н	$\dashv$		┨	R	┨	-k	<del>\</del>	╁	╀	╁	Н	$\vdash$	+	╁	╁┤	$\dashv$	+	+-	长
0928	Earth Survey C/D Equipment Fault Identifier	9		$\Lambda \Lambda$	3			<u> </u>	<b>1</b> ∰	ď	3	6 É		d			\(\frac{1}{2}\)	7						1	
0932	Radar Transmitter Inspector			$\frac{1}{2}$	4	Н			]				1	Ų.		1	0.1		1	+	+	-	4	Ę	₩
0933:	Radar Receiver Inspector Radar Presentation Observer	2	H	$\frac{1}{2}$	1	H	$\vdash$	7	1	-	H	-	+	-	14	Ė	327 33	$\vdash$	1	<u>.</u>		-	+	Y	r
0935	Radar Transmitter Control Actuator			ΔŽ			36	: 18	]:			¥ )	<b>Ø</b>						Í			$\Box$	1	工	
0936	Radar Receiver Control Actuator		H	4	4	Н	4	-	┨	⊣	Н	(	4	+	╀	Н	Н	$\dashv$	Ļ	+	$\vdash$	-	+	╀	╀
	Sferics Detector Presentation Observer Radar Transmitter Mode Selector		H	ΔŽ.	+	Н	+	+	1		$\vdash$	+	+	+	$\perp$	Н	Н		- 6	ď	$\forall$	_	$\pm$	$\pm$	1
0939	Radar Receiver Mode Selector		$\square$	$\Delta \mathcal{L}$	L	П	$\Box$	T	]	口	П	$\Box$	Ŧ	Ţ	L	П	Д	$\Box$	Ø	Ø]	П	$\exists$	1	F	$\vdash$
	Sferics Detector Mode Selector		$\vdash$		-	₩	$\dashv$		<b>-</b>	$\vdash$	┝┥	+	+	+	+	H	Н		0	낅_	╁┤	$\dashv$	+	+	<del> </del>
	Forest Fire Disaster Identifier Telescope Mode Monitor		M	Ň	4	$\dagger \dagger$	+	-	j :		H		য়া	$\pm$	1	H			Ť	1	$\dagger \dagger$		1	I	
1943	Telescope Mode Recorder		$\Delta$	¥	T	П		I	]		口		<u> </u>	Ţ	I	П		$\Box$	I	I	口	$\exists$	T	T	F
	Radar Data Quality Monitor		╟┼	#	4	$\vdash$		+	┨	H	$\vdash \downarrow$		<u></u>	+	+	Н	H	-	+	+	Н	4	+	+	-
	Sferics Detector Optics Cleaner rimary Occupational Skill .   X = Mission Occupational Sk	ــــــــــــــــــــــــــــــــــــــ		_	ك	لسا		kill			ب		٦.	بـــــــــــــــــــــــــــــــــــــ	ــــــــــــــــــــــــــــــــــــــ	لسا	ابسا		ㅗ	┷	لمست			-	-

<sup>1</sup>General Technical Skill, 000.000, Assigned.

<sup>\*\*</sup>No Mission Occupational Skill Assigned; see text and Figure 3-2.



TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills. (Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	-3 Air & Water Pollution	4 Resources Recognition			-2 Levitation Experiments	Furnace Experiments	4 Small/Low Temperature Exp.	CODE OCCUPATIONAL SKILLS	003.181 Electrical Technician	$\vdash$	003.187 Systems Engineer, EDP	+	007.081 Optical Technician	+	+	. UB)   Chemist, Inorganic	+	024, 081 Geologist	╄	888	882	180	789	187	281
CODE	TITLE	1	E0-3	E0-4		MS-1	MS-2	ş	MS-4	ľ	93	003	903	8l3		٥١٥			770	캶	12	025	075	041.	7.5	22	020
0005	Sferics Detector Module Remover	98			$\overline{\Lambda}$			8 10		38	Ō			× 1				3 8	800	. I		200	-	+		8	
	Sferics Detector Module Installer			Ť	Ī		+		1	1	ŏ	88	S I	X		+	1	<u> </u>	al f	18	15	100	H	+	1	8	Н
0968					Ī		1	N.	# X	1	Ĭ		M	ो			8			3 8			Ħ	+			H
0969	Composite Materials Data Recorder		2	8			ďΖ	Z		1 1				X		18		8 8		<i>a</i> 8		<b>S</b>		工			
	Composite Materials Structure Analyzer			188	4		¥	7	43	<b> </b>					₽	<del>-,-</del>		4	<b>\</b>	10	133	1	$\sqcup$	Ŀ	1		$\Box$
0973	Composite Materials Research Evaluator		Ы	$\vdash \vdash$	4	4	4	4	+	4	F	_	$\sqcup$	J	10	4	+	4	4	+	↓_	1	<del>                                     </del>	4	1	1	┦
0974	Composite Materials Sample Installer		H	-	4		+	+	+-	ł	$\mathcal{Q}$	-	$\vdash \downarrow$	싫	+	+	+	4	+	+	+	-	<del>[</del> ∔	+	1	<del> </del>	$\vdash$
	Composite Materials Sample Unstower		Н	-	4		-{/	╬	+-	١,	$\vdash$	-	$\vdash$	<del>(3)</del>	+	+	+	+	+	+	╄	⊢	1	+	╁	-	$\vdash$
0976	Composite Materials Sample Translocator Composite Materials Sample Remover		H	+	+	+	+	₹	+	1 '			Н	蛉	+	+	+	+	+	十	+	<del> </del>	╁	+-	+	-	Н
	Composite Materials Sample Stower	3		38 9	1	ा	1	寸	ीं	133	ř			A.		d	1			1	100	2		+			H
	Furnace Unstower			<i>i</i>			$\sqrt{2}$	$\mathbb{Z}_{\mathbb{Z}}$		1				Ø	8			4		1			11	$\top$	- 3		Н
0981	Furnace Module Remover		300		T	1	$\mathcal{M}$	$\Delta V$	7	]	0	100		X	8		Ι			. 18	1.9	1		$\perp$			
	Furnace Module Installer	199		2.3	I	ं /	$\Psi$	V	7	]	0		8.8	X				1 8	Š 3	10		·		- 2	8		
	Furnace Stower	36		. i	4	<u> </u>	¥	7			1	2		<u> </u>	4-	-12	4	4	4	42			1	4	183		
0984	Furnace Cleaner		Н		4	<del>- K</del>	₩	*	+	┨	$\vdash$	H		쑀	+	+	+	+	+	+-	╁╌		1 :	+	-	┨	Н
0985	Furnace Operation Monitor Furnace Repairer		Н		-	(	₩	*	+	┨	$\vdash$	H		록.	+	+	+-	+-	╀	+-	╀	┟╌┤	H	+	╄	┞╌┤	<u></u>
	Furnace Repairer Furnace Fault Identifier		Н	-	+	6	∜	∜	╢	┨	$\vdash$	H	$\dashv$		+	+	╁	╁	╁	╁	╁╾	╁┤	╁	╁	╁	┦	쏫
	Mixing Unit Installer		H	+	+	十	7	忆	┪-	1	$\Box$	Н	$\dashv$	хt	+	+	+	$^{+}$	十	+	╁	<del> </del> ⊢	+	+	╁	Н	~
0992	Mixing Unit Unstower	₩.		8 8	1	9	Z		<u> </u>		Ĭ		<b>⊗</b> (	ন্ত্ৰী	1	1	1		ह्य	ांश		70		+	ि	83	П
0993	Mixing Unit Translocator					ें .	1	1/	7	ij	1		()s	X		3	T		8 9	100		27		1	200	1	П
0994	Mixing Unit Remover				I		Z	$\underline{V}$	7	] [	1	ः		X			I							I	8		
0997	Mixing Unit Stower				1		V	$\mathbb{Y}$	ن إذ	18			<u> </u>	$\otimes$	4_	18	1			10				-	22		
	Mixing Unit Cleaner			-1	4		V,	¥	4	138				<u> </u>		18	1	40		42			H	4			
0999	Mixing Unit Operation Monitor		H	+	+	+	+	₩	4	ł	$\vdash$	$\vdash$	-	록.	╬	╀	╀	╀	╀	+-	₩	Н	-	+	+-	┟╌┤	
1002	Mixing Unit Repairer Mixing Unit Fault Identifier		Н	+	+	-+	+	∜	+	1	⊢	$\vdash$		+	╁	╁	╁	╁	+	╁	Н	Н	H	+		$\vdash$	쏡
1016	Materials Forming Equipment Installer		H	十	+	+	1	∜	╣-	ĺ	6	H	+	хt	╁	╁	╁	+	╁	+	H	Н	1	+-	╁┪	$\vdash$	
1017	Materials Forming Equipment Unstower		$\vdash$	+	+	-	┢	Ť	1-	t	۲	Н	1	X X	+	十	†-	+	十	+	H	$\vdash$	广	十	T	П	П
1018	Materials Forming Equipment Translocator	1988		3	1	8 P	Ź	ΝZ	1	1		**		Ž		18		9	18	17		3	M		188		
1021	Materials Forming Equipment Cleaner				I		V	V	7					8		3				. 12		-8		I	1/2		
1046	Materials Analysis Equipment Calibrator			4	4	ା /	Υ.	14	Υ.						1	13	1	1		12	Ш		1	_10			$\bowtie$
1048	Materials Analysis Equipment Cleaner		$ \cdot $	+	4	χĽ	*	#	4				44 2.1	<u> </u>	1	100	1-	⊀	#	100			1	+	12		1
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	Chill System Unstower	-85	H	+	+	1	_	+	+	1,280	М		- 1	ले	+	+	+	Ť	13	+	H	$\vdash$	+	+	H	1	$\dashv$
	Chill System Orstower  Chill System Translocator			1	†	1	7	$\dagger$	<del> </del>	1	П	П	Ť	ব	T	Τ	T	1	T	П	口	$\sqcap$	Ť	1	П		$\neg$
1070	Chill System Remover			丁	I	$\mathcal{L}$	$\overline{I}$	T		1	Q			$\stackrel{\checkmark}{}$	Γ	Γ	L	I	Ι	$\Box$	口	口	I	I		口	$\Box$
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1074	Chill System Operation Monitor		Ц	$\perp$	$\perp$	X	Ĭ.	Ţ	1	ļ			Č	8	1	1.	1	1	1	┯	니	Ш	_	4	Ш	$\sqcup$	لي
	Chill System Repairer		$\vdash \vdash$	-	4	-4	4	+	+	1	Н	$\dashv$	+	+	+	+	+	+	+	₽	⊢	⊢┤	+	+	$\vdash$		$\mathbb{Z}$
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	Vibrator Unstower Vibrator Translocator		$\vdash \vdash$	+	+	+	F	**	1-	1	Н	$\vdash$	-6	₹	+	+-	╁	+	+	+-	┝╾┥	-	+	+	╁┤	$\dashv$	$\dashv$



TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.

(Continued)

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	TASK - SKILL	PAYLOADS/EXPERIMENTS	Air & Water Pollution	Resources Recognition	EO-5 Disaster Assessment	Biological Experiments	MS-2 Levitation Experiments	Furnace Experiments	Small/Low Temperature Exp.	OCCUPATIONAL SKILLS		Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	ptical rechnician	Metallurgist Assistant	Surveyor, Geodetic	hemist, Inorganic	Chemist, Physical	Geologist	Geophysicist	Meteorologist	Weather Observer	Biochemist	Calibrator	Camera Inspector	Inspector, Systems Electronics Mechanic
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CODE	TITLE		E0-3	E0-4	S	MS	MS	MS-3	MS-4	٥	903	93	003		3 3	5 2	5	77 6	3 2	024	024	025	025.	041	710	1 5	358
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	Vibrator Repairer							$\overline{\triangle}$	<u>A</u>							T	1									18	K
1090	Vibrator Fault Identifier					**		$\mathcal{A}$			Ę			Ţ				Į.		12	M				4	1	10
	VHF Power Unit Installer		$\vdash$	Н	$\vdash$	$\vdash$	怾	놝	<del>} -</del>	-	P	1	$\vdash \downarrow$	$\stackrel{\times}{\boxtimes}$	+	+	+	+	+	+	$\vdash$	-	$\vdash \vdash$	$\dashv$	+	+	+
1092 1093	VHF Power Unit Unstower VHF Power Unit Translocator		$\vdash$	H	Н		N	$\overrightarrow{A}$	7	۱ ۱	十	$\vdash$	$\vdash$	Ħ	+	+	$\dagger$	十	+	+	$\vdash$	-	H	$\vdash$	十	+	十
1094	VHF Power Unit Remover							ŽĮ,	Ā	֓֞֞֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֡֓֓֓֡֓֓֡֓֡֓֡֓֡֓֡				X)	1	1	1	1	1	T	匚		口		士	1	1
1095	VHF Power Unit Module Remover	9880	L		50.5		$\Diamond$	흹	A	] 9]:x:	Ď			¥	Į.	$\int_{\mathbb{R}}$			8 54		Į,		Ц		2010	Ļ	Ţ
1096 1097	VHF Power Unit Module Installer VHF Power Unit Calibrator		F				怾	半	<del> </del>	48	Ρ			갂	+	+	+	- 13 - 13	42	+	1			4	<u>네</u> 즘	18	+
1098	VHF Power Unit Stower		F				力	Δť	<u> </u>	1	H			X	1	1	1	f		1	100			1		t	ť
	VHF Power Unit Operation Monitor				×		$\triangle$	$\triangle$	$\Delta$	]				8						Τ						1	Ι
	VHF Power Unit Repairer	:33			Ç.		$\stackrel{\wedge}{\downarrow}$	$\lambda$	$\frac{1}{2}$			.20	2	4	4		4		42	44			$\vdash$	4	12	4	18
	VHF Power Unit Fault Identifier Telemetry Equipment Controller		⊢	Н	Н	$\forall$	$\forall$	4	+	┨	6	Н	$\dashv$	↲	+	+	+	+	╁	+-	H	$\vdash$	Н	+	+	╁	F
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1129	Atmosphere Supply/Control System Operation Monitor					$\Delta$	$\triangle$	$\Delta t$	$\Delta$	1				8										<u>, 3</u>			Ι
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160	Computer Stower	l	口		$\Box$	4	$\Delta$	$\lambda$	Ţ	]	F	П	Ę	7	T	T	Ţ	T	F	F	П	$\Box$	$\bot$	4	4	F	F
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163	Power Conditioning/Distribution System Unstower Atmosphere Supply/Control System Stower	7777	Н	$\vdash \vdash$	-{	-4	X	∜	4-	-	$\vdash$	$\vdash$		計	+	+	$\dagger$	+	+	$\vdash$	H	$\dashv$	+	+	+	<u> </u>	†
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173	Environmental Chamber Control Actuator				$\Box$				ŽΙ	]	匚	П		<u> </u>	T	Ţ	Ţ	T	F	П	П	$\exists$	4	4	1	F	Ĺ
174	Atmosphere Supply/Control System Control Actuator		Ц	Н	4			실성	4	1	L	$\dashv$			+	+	+	+	+	H	$\vdash$		+	+	+	+	+
175	Furnace Control Actuator Primary Occupational Skill. X = Mission Occupational Sk					<u>L</u>	$\Delta k$	'لاب		١	1	ш			ayl	1	٠.	ــــــــــــــــــــــــــــــــــــــ	ــــــــــــــــــــــــــــــــــــــ	لبنا	ш.	┈	_		ــــــــــــــــــــــــــــــــــــــ	ــــــــــــــــــــــــــــــــــــــ	ــــــــــــــــــــــــــــــــــــــ

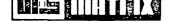


TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills. (Continued)

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	TASK - SKILL	PAYLOADS/EXPERIMENTS	r & Water Pollution	ources Recogn	Disaster Assessment	Biological Experiments	Levitation Experiments	Furnace Experiments	Small/Low Temperature Exp	OCCUPATIONAL SKILLS	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Instrumentation Technic	Metallurgist Assistant	Surveyor, Geodetic	Chemist, Inorganic	Chemist, Physical	Physicist, Heat	Geologist	Meteorologist	Weather Observer	Biochemist .	Calibrator	Inspector Systems	Electronics Mechanic
		Z								CODE	003.181	003.187	003.187	003.281	011.281	180	081	081	023.081	024.081	088	288	041.081	884	281	281
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1182 1183	Vibrator Control Actuator VHF Power Unit Control Actuator							\[\frac{1}{2}	#	<b> </b>				<b>8</b>	1	ļ.				Į.		1	A			F
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1206	Atmosphere Analysis Unit Remover					-ţ	ΔŹ	4		<b>!</b>	ŏ			री				96. 96.			+	+			+	-
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1250	Heating/Cooling Device Remover				1	7	Z	K			Q			3						L	0	П	1	T		
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1263	Heating/Positioning Coll Control Actuator Heating/Positioning Coll Repairer		$\vdash$	+	+	É	ζŹ	+	+		+	+	ď	1	Н	-	+	+	+	$\pm$		⊣	+	士		Ø
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TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills. (Continued)

-	TASK - SKILL	PAYLOADS/EXPERIMENTS	Air & Water Pollution	Resources Recognition	Disaster Assessment	Biological Experiments	Levitation Experiments	Furnace Experiments	ייייין דמא ו כיייף ביאם.	OCCUPATIONAL SKILLS	□	Н	-	+	Metallurgist Assistant	╁╴	╁╌	╁╴	Н	+	十	+	Richamist	+	╁╌┼	Inspector, Systems
		à	m	•			٠,٠	<u>بر</u> ا ب		CODE	003.181	003.187	003.187	003.281	011.281	018, 188	022.081	022.081	023.081	024.081	024.081	025.088	041 081	710.884	1, 684	722.281
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1269	Heating/Positioning Coll Installer			8	X		NZ	\$		1	Ò						10			7				t		36.
1270	Heating/Positioning Coil Translocator						V	Y						XI.	1											
1271	Heating/Positioning Coil Unstower	II	L	$\sqcup$			$\mathbb{A}$	4	L	1	L	П			#	Ļ	$\perp$	ļ		J	4	4	Ļ	Ļ	Ц	$\bot$
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347	Slip Formulation Controller Slip Materials Stower						-17	╣╌	+-					zl.	10	١	12	<u>.</u>		4	*	4	-		H	
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	Liquid Dispersion Research Evaluator						Z	7		]					8	1					$\perp$		T			
354	Materials Sample Unstower				Ц	_	$\Delta$	Ţ	1	1.		Ц		8	I	L	L			$\downarrow$	$\perp$	$\bot$	L	L	I	$\supset$
355 356	Materials Sample Translocator Materials Sample Installer		Н	Н	4	-4	₹	-14	<del>- K</del>	1		$\vdash$	∤	扖-	╀	╀	⊬	-		4	4	+	╁	╀-		-
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368	Crystal Growth Observer	j			7		2	Ĭ	1	1					T		O				Ī	I				I
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375	Silicate Melt Susceptor Installer	l					Ň	I		1	$\odot$			X						$\Box$	I	I	I		$\Box$	$\Box$
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	Silicate Melt Susceptor Module Remover	ĺ	Н	$\dashv$	4	1	<del>}</del> -	+-	-		$\mathcal{Q}$		-{	<del>}</del> }_	╀	<del> </del>	L	Н		+	+	+	╂	$\vdash$	$\dashv$	+
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396	Silicate Melt Susceptor Repairer	\				Ž	1	I												I	1	I	I		工	
398	Silicate Solvent Applier				J	V	T		6	33		$\Box$	1				Ø	X			1	1	1	Ш	1	1
400	Furnace Control Deactuator	蕊		1	4	2 K	4:	4::		Œ.	Н	4	4	<u> </u>	130	e f		Н	40	4	+	+	+	H	$\dashv$	+
	Silicate Melt Susceptor Operating Monitor  Zone Melter Control Actuator		$\vdash$	$\vdash \vdash$	+		╀	1	+		⊢┤	$\dashv$	-	<del>)</del> -	+	-	-	Н	$\dashv$	+	+	+	╁	Н	+	十
_	Zone Melter Unstower	1	Н	$\vdash$	+	+	+	1/2	1		Н	$\dashv$	- (	Z)	+	$\vdash$		Н	$\vdash$	+	+	+	+	Н	+	+
	Zone Melter Translocator	1	口		_	_	1			1				XI.	Γ						I	I			ユ	工
408	Zone Melter Installer					I	I	$\triangle$	$\Box$	ļ		$\Box$		1						I	I	I	L	Ц	I	I
410	Zone Melter Module Remover		Ц	I	1	T	1	Ķ				1	4	¥-	1	_		Ш	4	4	+	+	╀	$\vdash$	4	4
	Zone Melter Module Installer		Н	$\vdash \vdash$	+	+	╀	K			4	+	{	<del>\</del>	+		-	┝┥		+	+	+	-	$\vdash$	+	+
	Zone Melter Cleaner Zone Melter Operation Monitor	1	H	+	+	+	+	长	+		H	+	Ť	<del>}</del>	+	-	$\overline{a}$	X	-	+	+	+	+-	H	+	+
	Crystal Puller Control Actuator		H	-	+	-1/2	士	厷			H	+		才	1		ř		_	1	$\dagger$	1	İ	口	士	士
	Primary Occupational Skill. $ X $ = Mission Occupational Sk	: 11		$\Delta$	=	-					_				_				_		_		_			

<sup>&</sup>lt;sup>1</sup>General Technical Skill, 000.000, Assigned.



TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	Air & Water Pollution	i 1			Evitation Experiments Furnace Experiments			$\dashv$	181 Electrical Technician 187 Radio Engineer	t	H	十	+	188 Surveyor, Geodetic	+	╁	H		-+	+	184 Calibrator	╁┤	$\dashv$	81 Electronics Mechanic
CODE	TITLE		E0-3	E0-4	E0-5	MS-1	MS-3	MS-4			003.181	003.187	003.281	007.081	010.100	018.188	022.081	023.081	024.081	024.081	025.088	025.288	710 884	714.684	722.281	828.281
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	Crystal Puller Unstower Crystal Puller Translocator		-	Н	-	- 7	4-	H	-	, ŀ	- -							-				-12				<u></u>
1418						1	V	$\overline{\Delta}$		İ	<b>a</b>		X		T	1						- 18			<b>3</b>	Ř
1419	Crystal Puller Remover				<b>*</b>	~/	$\lambda_{\hat{\alpha}}$	囚		(			×												3	9.3
1422	Crystal Puller Cleaner					1	48	兴		×ļ.		4	끯		<u> </u>	<b>* </b> }	44	#			4	4	48			<u> </u>
1423 1425	Crystal Puller Operation Monitor  Zone Refiner Control Actuator	ll	$\vdash$	╟┤	┥	╀	╬	出	$\dashv$	ŀ	+	╀╌	8	$\dashv$	+	+	+	╁	╢	$\vdash$	-+	+	+	H	$\dashv$	-
1426	Zone Refiner Unstower		H	$\vdash$	十	+	+	<del> </del>	7	ŀ	+	T	8	+	+	+	+	T	$\vdash \vdash$	-+	-+	+	+	Н	+	-
1427	Zone Refiner Translocator			口	ightharpoons	1	工	$\triangle$		1			X	_		1	I		口		二	土			士	_
200 200 200	Zone Refiner Installer				Ţ		8 8.	Ň	<u>.</u>	[	<u> </u>	1	X	Ţ	Ţ	Ţ			Ц		Д	$\prod$	$\bot$		J	
	Zone Refiner Module Remover		μ.	H	4			H	4	<b>%</b>	Ę	4	Ø	<u> </u>	2   2 5   1				H		4	1	12		*	9
1431 1432	Zone Refiner Module Installer Zone Refiner Cleaner		-				18	H		St.	-	4		d			+		Н		-	-	+	Н	801	75
********	Zone Refiner Operation Monitor			@ J			+	团		<b>.</b> t		1	N	1	+	(	X	1	M		ी					-
1436	Zone Refiner Fault Identifier					<u> </u>		$\triangle$						ं		2 2										Ż
	Zone Refiner Repairer	I	L	Ш	4	$\bot$	$\perp$	$\Box$	4	L	4	╄	Ц	4	4	4	1	<u> </u>	_		_	4	╄.	Ш		2
	Zone Melter Fault Identifier		-	H	+	-	+-	兴	-	-	+	+	Н	4	+	+	+-	┼	H		-	-	+	$\sqcup$	4	$\frac{8}{8}$
	Zone Melter Repairer Crystal Puller Fault Identifier		$\vdash$	H	+	+	╫	分	$\dashv$	ŀ	+	╀	┦	+	+	╁	+	┼	╢		-	- -	+-	⊦⊣		<u>~</u>
1443	Crystal Puller Repairer			$\vdash$	$^{+}$	7	7	团	1	H	+	†-		+	+	+	$\dagger$	T	H	$\dashv$	_	+	+	$\Box$	-1	3
	Crystal Growth Characteristics Determiner	×.				× Z	13	$\square$		<b>#</b> [	¥ 🕸				10	(	$\mathbb{Z}$		3	3	3		8 80		্য	- <del></del>
	Crystal Growth Structure Analyzer					* K	<u>\</u> _	$\mathbb{A}$							1	Ľ	$\mathbb{X}$		N.	34	<u> </u>	9	<u>  } </u>		4	···
	Test Cell Installer			H		-	٦.	兴	-18	ાં	₹		$\otimes$		+	3   2 3   3		100		#	4	- 10			-	
1447	Materials Analysis Equipment Tester Camera Tester		$\forall$	Xt.	$^{\wedge}$	- K	大	N		þ	4					) (2 ) (8	3 (3)			H	<del>*</del>				#	.z.,
1449	Holographic Device Tester	3-4600			7	Z	V		7	~ R	5		X			T	T									_
1454	Crystal Growth Data Recorder				$\perp$					1			X		I		I		П	$\Box$	$\Box$	I			ightharpoons	_
	Densitometer Unstower		Н		_4	<del>)</del>  -	╀	Щ	4	_	4	$\perp$	Ø	4	4	4	+	<b>.</b>	Н	4	_	4	1	$\vdash$	$\dashv$	
1456	Densitometer Translocator Densitometer Installer		Н	⊢	-4	-#	+-	-	$\dashv$	۱,	╬	-	K	+	+	+	+	╀	┦┥	-	-	+	+-	⊢┼	$\dashv$	
	Densitometer Remover	×33	Н	788	: 1/	$\frac{1}{2}$		3	<del>.  </del> 2	≈Þ	∜	1	$\Diamond$		do	8 / 2	18	88	Н	38	386	1	133		$\dashv$	Ş.
	Densitometer Calibrator				Ź	Z)	13			1	1		8					18			<del>*  </del>	1			1	_
1462	Densitometer Operation Monitor	8			$\mathbb{Z}$	Z				ĕΕ			8	ş è							77				I	.,
	Densitometer Fault Identifier	**		Z. 2	4	4				္ကြ	1 3				1		40			_	4	10	1		- [	Ž
	Densitometer Repairer	. 250	Н	H	- 4	7			48	# <u> </u> 2			10.20°	<u> </u>	43		100	100		4	4		(20)		-15	<del>Š</del>
	Calorimeter Repairer Calorimeter Remover		Н	+	+	⊬	+	$\forall$	$\dashv$	7	<del>-  -</del>	Н	X	+	+	+-	$\dagger$	H	+	+	+	+-	$\vdash$	$\forall$	+	<u>د</u> ـ
	Calorimeter Installer		H	$\dashv$	$\top$	2	1	abla	7	È	51	H	X	+	1	$\dagger$	†			$\top$	+	<u> </u>			$\top$	_
1481	Calorimeter Translocator		口		1	$\Box$		Ņ	]	ון ו		$\Box$	X	$\perp$	I	1	I		$\Box$	1	コ	$\perp$	$\Box$		I	_
	Calorimeter Unstower	,	Н	$\dashv$	+	-K	4	4	4.	Ļ	+-		Q	+	+	, l			$\dashv$	4	4	+	ļ.	4	ᅷ	55
	Friction Measuring Device Repairer Friction Measuring Device Fault Identifier	1	Н	-	+	+	+	+	-1	<u></u> } -	+		$\exists$		12	1	70		$\vdash$	4	+	+	+-	+	+	÷
	Friction Measuring Device Operation Monitor	100	H	+	7	7	1	-	-	<b>*</b>  -	1	×	1	1	+	1	1			+	+	+	Τ			
1488	Friction Measuring Device Calibrator	3			1				<u></u>	ै	. 000			$\perp$	I	1				I	$\perp$	Ι	Ō			Χ
1491	Friction Measuring Device Remover	Įű.	П	T	1	Ľ	$\Box$		] }	( <u> </u>	्र		XI	<u> [</u>	4	4	1	3.	Ц	_[	4	<del> </del>		4	4	
	Friction Measuring Device Installer		Н	-	+	-	1	+	┨,	۲,	4-	H	₩	+	+	+	+		+	+	+	+	$\vdash$	+	+	
	Friction Measuring Device Translocator Friction Measuring Device Unstower		H	+	+	+	+	+	$\dashv$	۱,	+	Н	份	+	+	+	+	Н	+	+	十	+	$\vdash$	+	+	-
	Friction Measuring Device Control Deactuator	1	H	+	$\dagger$	$\nabla$	1	$\dashv$	7	۲	+		2	士	1	$\perp$	İ			丁	_	Ī			丁	
1496	Friction Measuring Device Control Actuator					1			J		I		্		I	I	I		$\Box$	I	$\Box$	I	$\Box$	$\Box$	I	
1497	Friction Measuring Device Stower		П	T	Ţ	Ľ	L	$\bot$	4	L	T		Š	1	1	4	1	$\sqcup$	4	4	4	1	1	$\perp$	4	4
	Friction Measuring Device Cleaner		Н	+	+	+	1	+	-	-		┥┥	띯	+	+	+	+-	H	+	+	+	+	Н	+	+	-
	Calorimeter Stower Calorimeter Cleaner	1	Н	+	+	-	}-{	ᆉ	┨.	۲	+-	H	3	+	+	+	+-	Н	$\dashv$	+	十	+-	Н	+	+	-
	Heating/Positioning Coil Control Deactuator	1	Н	+	+	t	1	+	1	H	+	H	Z)	+	†	+	$\dagger$	H	_	+	十	T	Ħ	$\top$	士	
	rimary Occupational Skill. X = Mission Occupational Sk	:11		7					_										_	_						٦



TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	Air & Water Pollution	Resources Recognition	Disaster Assessment	Biological Experiments	Levitation Experiments	Furnace Experiments	Small/Low lemperature Exp.	OCCUPATIONAL SKILLS	ig ig	Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Metaffurgist Assistant	Surveyor, Geodetic	Chemist, Inorganic	Chemist, Physical	Physicist, Heat	Geologist	Occupity sicras	Westher Observer	Biochemist	Calibrator	Camera Inspector	Electronics Mechanic
		Z					- 1			CODE	003.181	003.187	003.187	003.281	011.281	018.188	022.081	022.081	023.081	024.081	5 5	025.000	041.081	710.884	984	781
CODE	TITLE	11	E0-3	E0-4	입	MS-1	MS-2	S :	MS-4	10	003	00	003	00	3 5	19	022	022	023	024		2 2	041	2	3 7	828
1507					ķ.	1	$\Delta$																		9 8	Ι
1508			L				$\mathcal{A}$							<u> </u>		200					4					Ţ
1512	VHF Power Unit Control Deactuator Crystal Growth Process Monitor	1	H			<u> </u>	$\star$	7	1	1					100	2.2	C	$\overline{\mathbf{x}}$			+		+	-		+
1513	Glass Samples Unstower	11		*			$\overline{\Delta}$		1	1				<u>a</u>			Ĭ				1	1				$\perp$
1514		1					Ň	I	I	] [				X	I	L				I	I	I			I	I
1515		ll			Ц	_	Ž.	4	1	4	Q	Ц		\$	1	1	L		Ц	1	1	4		H	1	$\perp$
1516 1517	Glass Samples Remover Glass Samples Stower		$\vdash$	_	$\vdash$		4	+	+	-	$_{\rm P}$	H		짉-	+-	-	-	-		+	+	+-	╀	$\vdash \vdash$	+-	+
1518		II		-	$\vdash$	寸.	∜	十	+	1	H	Н		4	+	<del> </del>	5	X	Н	+	+	+-	+	╁┼	+	+
1519				7		<i></i>	$\overline{\Delta}$	3/2	7	133	*		ী	2	185	1	$\sim$		3	1	+	V 🖇		1	13	十
1520					<b>3</b>		$\Delta V$	7	Ž≪	1				X.	I				7.		I					I
1521					8	$^{*}$	4	4		<b>.</b>			4	<u> </u>	1 55		Ō	X	100		_	1	L		4	1
1522			1		П	X	4	<u> </u>	4	10			4		1	-	Q	Х		4	_	4			4	丰
1525	Cas Elimination/Cooling System Installer  Gas Elimination/Cooling System Unstower	1	H	H	Н	伏	+	+	1	╣	М	Н		<del>2</del>	+	-	1			+	十	+	+	-	7	+
1526		]]	H		H	기	十	+	+	1	H	Н	Ř	Ž)-	†	-	-			+	+	+	1	+	+	+
1527	Gas Elimination/Cooling System Cleaner		Н	Н	H	$\triangle$	+	+	1	1 1	Н		- K	<del>À</del>	†	⇈		П	1	+	$\dagger$	1	$\Box$	$\vdash$	1-	1
1528	Gas Elimination/Cooling System Stower	]]				$\triangle$	$\perp$	I	I	]				8	I						T				I	$\perp$
1529		<b>II</b>	L		4	쉬	4-	+	1				-1	<b>S</b>		L		23.		1	4	1		4	4_	+
1534 1535			Н	3	-	长	-			∤			+	4	130	H		- X		+	+	3	$\vdash$		+	₩
1536	Cas Elimination/Cooling System Repairer Cleanup/Refurbishment Equipment Installer	ll ő		Н		7	+	+	-	18	0	-	+	7	13	-			+		+	+	$\vdash$	$\vdash$	+	12
1537	Cleanup/Refurbishment Equipment Unstower					$\overline{\triangle}$	1		1 19	13	Ĭ		Ŕ	हो	1		3		* I		1	1	$\Box$		1	1
1538	Cleanup/Refurbishment Equipment Translocator					$\Delta$			8 8		*			X.							I				3 8	工
1539	Cleanup/Refurbishment Equipment Stower	11			-	싂	4		1	4		Ц	_{	8	$\downarrow$	L	L	Ц	_	4	4	_	Ш	-	4.	1
1540 1541	Buffer/Waste Separator Installer Buffer/Waste Separator Unstower		Н	Н	H	읬	4	+	+-	ł	Р	Н	-{	衸	+-	┡	L	Н		- -	╀	+	╀	$\vdash$	+-	╄
1542	Buffer/Waste Separator Unstower Buffer/Waste Separator Translocator		Н	Н	H	长	+	╅	╂	١,	Н	Н	+	<del>}</del>	+	$\vdash$	Н	Н	-		╁	╁	Н	$\vdash$	+-	+
1543	Buffer/Waste Separator Cleaner	11	Н	H	- f	$\vec{\Delta}$	+	+	+	1 i	H	H	- 1	<del>}</del>	╁	-	-	H	+	┪-	+	+	Н	+	+-	t
1544	Buffer/Waste Separator Stower	1	*	8	Ñ,	$\overline{\Lambda}$				<b>¹</b> ∭		38		ৱ	18	: 4	£\$		8.4	ু ্		8			े ह	
1545					$\Box$	Ņ.	1		2 87	]				<u> </u>	N	13	8	<b>2</b>			T	$\perp$	П			Ţ
1548	Buffer/Waste Separator Fault Identifier		Ļ	Щ	<u>}</u>	쑄	4		1		Ш	<u> </u>	ୁ	1			8	8		1	4	4_	$\sqcup$		+	17
1550	TV System Control Actuator Data Compression Equipment Control Actuator		Н	Н		1	7		+-	1	$\vdash$	4	- 6	3	1	. A.	100 100 100 100 100 100 100 100 100 100	27 244	$\dashv$	+	+	+	$\vdash$		+-	╀
1551	Buffer Solution Installer	.32.	H	Н		$\wedge$	7	+	+	***	Н		è	<del>3</del>	+-				-	+	+	+	H	+	+-	+
	Buffer Solution Unstower		П	Н		$\overline{\triangle}$	$\top$	+	✝	1	П		-6	1	T		Н		寸	╅	†	1-	$\Box$		$\top$	$\vdash$
1553	Buffer Solution Translocator	11			4	$\Delta$	I	$ lap{1}$	1	] 1				<b>X</b>					$\Box$	$\perp$	L	Ι			I	$\Box$
	Buffer Solution Remover	11	П		4	$\Box$		1	T	]	П			<u> </u>	$\perp$				_	L	$\perp$	L		1	L	$\perp$
	Buffer Solution Mixing Controller Biological Materials Installer		Н	$\Box$		挆		-	+	A.	H	$\dashv$	+	<del>.  -</del>	+	-		X		-	+	+-	14	+	+	╀
1557	Biological Materials Installer		Н		- 1	忕	+	+	+	1	М		+	╁	+			**	+	+	+	+-	H	-	+	$\vdash$
1558	Biological Materials Translocator				- 1		1	+	+	ű.	H		1	7	T	-			十	1	†	1	П	$\top$	1	$\vdash$
1559	Biological Materials Remover				1	$\Box$	I	I		] \$:	O			1					Ι	I	Γ	I			L	L
	Biological Enclosure Unstower				4	ŽΙ	$\perp$		1		П	$\Box$	K	<u>J</u>	Ľ			2]	1	4	1	4	Н		+	+
	Biological Enclosure Stower	1	H	$\vdash$		4	+	+	+-	┨	H	$\dashv$	-₩	쑀	+-	$\vdash$	$\dashv$		+	+	╀	╁	H	+	+	╁
1568	Biological Enclosure Operation Monitor Biological Enclosure Fault Identifier	II	Н	$\vdash$	-{	+	+	╁	+	1	Н	+	+	+	+-	H	$\dashv$	-1	+	+	+-	+-	┥	+	+	1
1569	Biological Enclosure Repairer	I	H	$\vdash$		計	十	+	$\top$	1	М	1	+	十	†	П	$\exists$	7	1	1	T	T	П	1	T	区
1572	Buffer/Waste Separator Repairer	]			. /			J	$\Gamma$	]	口		J	I						I	I			$\perp$		Z
1573	Electrophoretic Column Installer		П		1	$\Delta$	Ţ	T				$\Box$	1	4	Ļ	П	_	1	_[	4	L	Ĺ	Ц	_[	4	$\vdash$
1574	Electrophoretic Column Unstower		Н	H	/		+	+	+-	1	Н	4	4	*	╁	Н	4	-	+		╁	-	H	+	+-	+-
1575	Electrophoretic Column Translocator		Н	$\vdash$	1	厼	+	+	╁	{	님	-+	⊀	╁	+	H	-	-	+	+-	+	+	┥	+	+	+
	Electrophoretic Column Remover Electrophoretic Column Cleaner		H	$\vdash$	- É	立	+	+	+	1	M	+	卡	ð	<del>  -</del>	H	-	7	+	+-	T	†	Н	十	†	<u> </u>
	Primary Occupational Skill. $\overline{X}$ = Mission Occupational Skill.	711			-	-		-Sk			_								_	_	_	_				



TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills. (Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS		Resources Recogn			-2 Levitation Experiments	-4 Small/Low Temperature Exp.	3	CODE OCCUPATIONAL SKILLS	181	Radio Engineer	+	003.281 Instrumentation Technician	1		Н	7	023.081 Physicist Heat	+-	+	††	041.081 Biochemist 710.884 Calibrator	+	-	<del> </del>
CODE	TITLE		B	E0-4	E0-5	MS-1	MS-2	MS-4		٥	003	003	8	003	=	018	022	022	023	024	025	025	710	714	722	828
1578	Electrophoretic Column Stower				<b>%</b>	Δ			33				X	્ર									7 3			
	Electrophoretic Column Operation Monitor	ll 🏻			4	$\stackrel{\wedge}{\downarrow}$	4	10	Į.			I	1	<u> </u>		L			4		100	H	1		$\vdash$	
1584 1585	Electrophoretic Column Fault Identifier Electrophoretic Column Repairer		H		4	长			1			+	+	2   °		3		100 P		1	100	H			+	区区
1586	Electrophoretic Separation Research Planner				ď	亦	Z	7	1			7	Ħ					X	1	1			ol :	t		ि
1587	Electrophoretic Separation Process Evaluator	II		П	1	$\triangle$	I					1	I	Ţ				X	$\Box$	I			2	I		$\Box$
1588	Electrophoretic Separation Data Recorder	ll		П	4	Ä	1	1	L	1	$\Box$	4		Ţ		L.	Ц	4	$\perp$	$\perp$	1	H	7	$\perp$	igstyle igytyle igstyle igytyle	Ĺ
1589 1598	Lyophilization Apparatus Control Actuator Ampoule Installer		Н	H		<del> </del> <del> </del>	+	╢	╀╌		$\dashv$	+	- 8	<u> </u>	-	_	Н	+		+-	╀	$\vdash \vdash$	+	╁	┞╌	┝
1601	Interferometer Installer		H	H	۲ť	<u>Z</u>	+				d	_+	╬	*	$\vdash$	_	H	_	+	+	十	-	+	+	$\vdash$	-
1602	Interferometer Unstower	333			୍ଦ	$\Delta$	2						Q	3	3	300					38		4 2			
1603	Interferometer Translocator				4	$\frac{1}{2}$	4	1	4			_		4		3/2 1/2				L	12		4			
1604	Interferometer Remover Interferometer Calibrator			30	<u></u>	$\stackrel{\sim}{+}$		长			4	4		4		4		4		4-	10	Н	4	-	H	1
1606	Interferometer Camprator		Н		+	*	+	夶	-		$\sim$			1		200	331 333			+-	12	H	_(	7		X
1607	Interferometer Stower	272			1	寸	1	T		AC. 8			K	<u> </u>						1	1					
1608	Interferometer Controller				-	$\Delta$	I	I			Q	I		1						L	L	П	I			C
1609	Interferometer Operation Monitor		Н	Ш	_	$\stackrel{\triangle}{\vdash}$	+	₩			1	4	10	<u> </u>	_	L	Ц	4	4	↓_	<del> </del>	Н	4	44	ш	Ļ.,
1614 1615	Interferometer Fault Identifier Interferometer Repairer	l	Н	-		₩	+	长	-		$\dashv$	$\dashv$	+	+	-	-	Н	+		+	╀	$\vdash$	+-	+-	⊦⊣	答
1616	Interferometer Control Actuator			3	٦Ľ	寸	2 3	$   \overline{\wedge} $			*	1	1	4		-8				1		H	3 3	137	-	عا
1617	Densitometer Control Actuator			32	,	$\Delta$							(	3		×		.3								
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1619 1620	Densitometer Stower Densitometer Controller			33	- K	12	+	+-	Н			-	+	<del>}</del> -		14. 28	3.88	30 S		-		H	43			-
1621	Buffer/Waste Separator Remover	2000	П			Z	+	1	Н	10000	ð	7	Ť	र्री				***	-	1		-	1			Ϊ-
1622	Gas Elimination/Cooling System Remover				1	7		L			$\bigcirc$		$\supset$										$\perp$			
1623	Buffer Solution Flow Rate Determiner				_/	ΑΙ.	1	1			4	_[	4	_	Ц	_		XI.	-	$oldsymbol{\perp}$	L	-	잋.	4-4	Ш	<u> </u>
1624 1625	Biological Materials Test Observer  Electrophoretic Separation Research Evaluator		$\vdash$	$\vdash$		븼	+-	╁	╀╌┤		-	-}-	+	+	Н		-	₩		┼	-	-		╂┤	$\vdash$	-
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1647	Fluid Sample Mixing Controller												8				<b>*</b>	X	2							
1648	Fluid Convection Research Planner			3			1	台				4			0			24	$\supseteq$	1		$\sqcup$	1		-	_
650	Fluid Convection Research Evaluator Fluid Samples Installer		98	92	+	21	<u> </u>	兴	$\vdash$				-	7		-2		4	4	-	1	╟╫	+:			-
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053	Atmospheric Pollution Data Observer	ı	띩	4	4	4	+	$\vdash$	Н		+	4	+	+-	$\vdash$	4	$\dashv$	+	+	<del>\</del>	Q	4	+	╁┤	┝╼┥	_
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056	Water Pollution Data Evaluator Atmospheric Pollution Data Evaluator		N			+	+	+	Н		$\dashv$	十	十	$\top$	H	$\neg$	+	$\top$	$\top$	区	Ō	ot	_	T		
057	Meteorological Conditions Evaluator				寸	1	士	1			1	士	丁	1				丁		図	Ŏ		I	口		
058	Mission Events Evaluator **		囚	$\triangle$		I	I			2	I	I	I	I			I	I	$\perp$	1		$\Box$	1	$\Box$		
059	TV System Inspector	1	$\triangle$	1	M	- 1	1	1		. [	- [	- 1	- 1	1	1	ļ	- 1	i	1	1	, 1	1		لــــــــــــــــــــــــــــــــــــــ	$\Box$	7

<sup>&</sup>lt;sup>1</sup>General Technical Skill, 000.000, Assigned. <sup>2</sup>Special Spaceflight Skill, XXX.XXX, Assigned.

<sup>\*\*</sup>No Mission Occupational Skill Assigned; see text and Figure 3-2.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.

(Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS							Small/Low Temperature Exp.		-+	-+	┪	+	+	+	Metallurgi	+	$\dashv$	+	$\dashv$	╁	+	+	+-	+	+-	181 Inspector Systems	Electronics
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2063	Polarimeter Aligner	<b>!</b>	H		30			· · ·		-	H	4	+	4	X		+	- 1		#	- 1		#	4	#	1	-	+	+
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2066	Scanner Repairer				Δ			$\Box$	1	]			$\Box$	Ĭ	I	$\perp$	I	I	1	丁	工	I	I	I	I	I	I	I	Ø
2067	Polarimeter Repairer	li .		$\square$	ᆛ	Ц		_	$\perp$	┨		4	1	Ţ	Ţ	$\perp$	$\perp$	4	$\perp$	Ţ	$\bot$	1	1	1	$\perp$	1	1	L	2
2068	TV System Control Deactuator TV Data Classifier		茓	<b>∤</b> —∤	$\stackrel{\wedge}{\vdash}$		4	4		4	ŀ	+	4	4	<u> </u>	+	+	+	+	4		╁	$^{\star}$	+	+	+	+	+	╄
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	Radiometer Data Classifier		$\overline{}$	忧	Ħ	2		1			∂ I		1	+	+	+	+	+	+	+	+	愤	<u> </u>	+	+	+	1	1	+
	Polarimeter Data Classifier		$\nabla$	$\triangle$	٦	ं	2	W.	Ä ,		1		1		ा	1	1	1	*	3	31	Ì			7	1		10	1
2080	Spectrometer Data Classifier		$\triangle$				98 40	**			ा							ी		7		X	₫.				1		
	Polarimeter Controller**		Ç					$\Box$	30		2[	Ц	4				I				耳	$\mathbb{I}$	<u>J</u>	I	I	1		$\perp$	Γ
2082	TV Data Analyzer		兴	╢	$\dashv$	-1	-	4	+	4	ŀ	4	4	4	+	+	+	4	4	4	+	18		+	4-	+	+-	╄	╄
2083			兴	╀╌╂			$\dashv$	+		4	ŀ	+	+	+	+	+	+	+	-	+	+	X	<del>}</del> }-	+	╀	╁	+	╀	┾
2085	Polarimeter Data Analyzer Polarimeter Data Analyzer			<del>  -  </del>	-	-	$\dashv$	╅	+	┥	ŀ	+	+	╅	+	╁	+	+	+	+	+	× ×	計	╫	+	+-	╁	+	╁
2086	Spectrometer Data Analyzer	11		1	7	_	$\neg$	7	+	1	ı	7	1	7	+	+	$\dagger$	+	+	ナ	$\top$	悹	퀽	十	+	+	+	+	╆
2087	Telescope Data Analyzer				*	87	91	া	S 3	7	<b>%</b> [	8	\$ 1		<b>*</b>		3 8	<b>X</b>	<i>i</i>	1	्र	ি	₫	1	1		I	1.7	I
2088	Scanner Adequacy Determiner				$\triangle$		3	1					1		XI.			1		1	*1		QC	_	1	1	L	L	
	TV Camera Adequacy Determiner		兴		쉬		4	4	+	48	8 F		1	- 1	4	+	4	4	+	4	+	*			#	+	1-	╁	+
2090	Radiometer Adequacy Determiner Polarimeter Adequacy Determiner		兴	쉱	식		+	+	-	4	္န		4	+	#	+	-		#	-	#	8		4-	+	╁	+-	+	╀
2092	Telescope Adequacy Determiner		片	X	$^{\prime}$	-4	Ť	7	-	4	** <b> </b> -	+	+	K	7	+	+	+	+	272	7	18	δĊ	_	+	+-	+-	+	┢
2093	Camera Adequacy Determiner		$\triangle$	$\triangle$	团	$\dashv$	7	1	+	1	ı	7	$\top$	1	<u> </u>	十	+	+	$\dagger$	$\dagger$	$\top$	筤	ŝĊ	-	+	$\dagger$	T	$\vdash$	┢
2094	TV System Operation Monitor		$\Delta$		Δ		I	I	$\perp$		[		1	Q	1		Ι		Τ	I	工	I	I	I	I	I			$\Box$
2095	Scanner Operation Monitor			$\triangle$	$\Delta$	_	_		I			1	$\perp$		<u> </u>	T	I	I	1	1	$\perp$	$\perp$	I	1	$\perp$	1	1	L	L
2096	Radiometer Operation Monitor	ll	À		_	_	4	4	4	١,		4	1	-  <u> </u>	¥L,			4	-	4	+			با.	+	4	ـــــ	Ļ	L
2097 2098	Polarimeter Operation Monitor  Spectrometer Operation Monitor		长	-	+		3			-	ŀ	+		42	¥.	+	+	1	-	+	4	12		+	+	+	╀	-	┝
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2101	Water Pollution Data Classifier						ं			]										1		Ž.		I	$\mathbf{F}$	L			
2102	Video Data Quality Evaluator			Ķ	Ţ	4	4	4	4	4	-	4	4	1	1	1	1	1	- -	4	4	8	4	+	$\vdash$	1	$\perp$	<del> </del>	
2103	Radar Transmitter Mode Monitor Radar Receiver Mode Monitor		$\vdash$	₩	쉬		+	+	+	4	-	+	+	- 12		+	4	+		+		+	╀	╁	+	╀	┼-	⊢	╀
2104	Radar Transmitter Mode Recorder		$\vdash$	X	쉱	-	+	+	+	┨	ŀ	+	╁		<del>}</del>	┿	╁	╁	+	+	+	+-	+	+	+-	╁	╁	┢	-
2106	Radar Receiver Mode Recorder	l	H		ձ	7	7	1		7	ı	1	+	Tê	*	†	†	1	+	十	$\top$	+	1	1	T	T			
2107	Land Use Data Observer	8		$\triangle$	$\Box$					]	% [	33	8. 3			3 3				I	<i>.</i> 3	X	1	I		L			
2108	Land Use Data Evaluator	1 % 2.		$\triangle$	<u> </u>	1	1	-[	$\perp$	4	٦		4	$\perp$	4		1	1	4	4	4	核	<b>)</b>	4	1	1	1	1	ļ
2109	Radar Data Classifier	2	H	$\frac{2}{3}$	쓔	-	+	+	+	-	<b>%</b> }	+	+	+	4		+	4	+	+	+	8	*	+-	+	+-	+	-	-
2111	Telescope Data Classifier Spectrometer Adequacy Determiner		H	宋	4	-	+	+	1	+	ŀ	1	+	+	al-	+	+	+	+	+	H	粉	#	+	+	+	+-	<u></u>	+
2112	Radar Transmitter Adequacy Determiner	.88%	٢	$\Delta$	Ճ	+	+	+	+	1	:×	+	+	Ť	\$	+	+	T	_	†	_	×		1	1	Ť		Γ	
2113	Radar Receiver Adequacy Determiner	I	_	$\triangle$		_†		_†	T	]	Ī	1	T	_[Š	श्रे	Ι	1	1	1	I	T	Ø	ÌČ		Γ	I		$\Gamma$	$\Box$
2114	Radar Operation Monitor			Ø	$\Box$	$\Box$	$\Box$	I	Ţ	1	Ľ	I	$\bot$	C	Ý	Ţ	I	Ţ	Ţ	Ţ	I	Ţ	Ţ	Ţ	F	F	$\Box$	$\vdash$	F
2115	Land Use Data Classifier	I	<u>_</u>	Š	_	4	_	4	+	4	Ļ	4	4	4	+	+	+	4	4	+	+		-	+	+	$\vdash$	╀	-	⊢
2116	Earth Surface Landmark Observer  Earth Surface Landmark Classifier	1	-	\	+	-+	+	+	+	4		+	+	+	+	+	+	╀	+	+	+	<u> </u>		+	+	+	╁┤	-	-
2118	Earth Surface Landmark Classifier Sferics Detector Mode Monitor		-	1	┰	+	-+	+	+	٦.	ŀ	+	+	卡	5	十	+	+	+	+	十	Ť	ተ	+	T	十	T	-	1
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2120	Camera Mode Recorder	li 💮		Π.	Δ			I	I	]	-[	J	I	Ţ	1	I	I	I	I	I	I	Ι	I	I	$\Gamma$	$\Box$			$\Box$
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<sup>&</sup>lt;sup>2</sup>Special Spaceflight Skill, XXX.XXX, Assigned.



TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	Air & Water Pollution	Resources Recognition	Disaster Assessment	Biological Experiments	Levitation Experiments	Curnace Experiments		-	Н	$\dashv$	+	I Instrumentation Technician	+	╁	1 Chemist, Inorganic	╁╴	╁	Н	Н	Н	H	$\dashv$	╁	╅╴	Inspector, Systems
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2122	Geological Precursor Data Evaluator			2	Δ											- -	Ī	Š	Ī	Ö	Ø		Ĭ				13
2123	Earthquake Data Observer			4	$\Lambda$		1									$\bigcirc$				Ŏ	$\overline{\mathbb{Z}}$					1	
2124 2125	Earthquake Data Evaluator		Ш	4	$^{\downarrow}$	- -	1	4.				4	4		4	C		1		O	Ø		M	4	47	4	42
	Sferics Detector Tester Telescope Tester		Н	1	4	- -	1	+			X		T.	+	1	1	1	H	120	H	H		H	#		#	13
	Sferics Detector Adequacy Determiner		H	ľ	3	**************************************	T	Ť	П	.38683	S2/		Ť	7	400	420	482	1222	1 332	H	Ø			2012	<b>24</b> 25	۳	+
2128	Meteorological Precursor Data Observer				$\bar{\Delta}$	I	I	I	D				I	士	Ι	I	Ι	I		П	$\otimes$		ø	士	士	T	士
	Artificial Precursor Data Observer	I	П	4	1	$\perp$	$\perp$	↓_	П		$\square$	$\perp$	$\bot$	I	L				L	Ц	Ø	$\Box$	П	I	I	I	I
	Topographical Precursor Data Observer	ll	Н	-4	<del>}</del> -	+	+	+-	Н		$\sqcup$	4	-	+	+	P	4	╁-	┝	Н	Ø		Н	+	+	$oldsymbol{\perp}$	+
	Precursor Disaster Data Observer  Meteorological Precursor Data Evaluator	335		/	1	: A		+		230	::	ा	28 6		100					Н	8	ᅴ	$\forall$	30		1	1
2133	Artificial Precursor Data Evaluator		H	2	7		†								†	†-	1			П	Ø	ă	Ħ	-1-		1	1
2134	Topographical Precursor Data Evaluator			7	7				ं		Ş-					0		3	ig.		Q						
2135	Precursor Disaster Data Evaluator				$^{\vee}$		1	10											L	Ш	Ø						L
	Hurricane Data Observer	<b>.</b>	H	- 4	7	90	+		H	324			<u> </u>	\$ \B		1	1	100	<u> 12</u>	H		외	의	-	علا	1	1
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	Volcanic Eruption Data Observer			Ž	Ī							I	士		1	O				d	Ø	Ť		士		$^{\dagger}$	1
	Forest Fire Data Observer		$\Box$	1	7	1.	L	L	$\square$			$\perp$	$\perp$	$\perp$	L		L				Ø	$\Box$	$\supset$	$\perp$	I	I	L
2142	Range Fire Data Observer			1/	4		188	ļ.,				4		- -	1	7	-		100	-	찃	4	-1		44	100	1
2143	Landslide Data Observer Snowslide Data Observer			- 1/	+	*   92 8   33		-	Н		3	+		+	+		-	100	140 140	H	윙	$\dashv$	-		-	H	+
2145	Land Subsidence Data Observer			Ź	7							1						32			傲	+	+	1	7	+	+
	Drought Data Observer			$\mathbb{Z}$	7			*								N		3.3	32		Ø		二				
	Blizzard Data Observer		П	$\mathbb{Z}$	1	4	$\perp$	L	Ц		_	_	_	$\perp$	_	L	L		L	Ц	$\otimes$	2	잋	4	$\perp$	L	Ļ
	Hurricane Data Evaluator		$\vdash \vdash$	- K	4	+-	┼-	╀	$\vdash$	ŀ	-	+	+	+	╀	├	ļ	L	-		$\simeq$		잋	-	+	╀	+
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TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills. (Continued)

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TASK - SKILL	PAYLOADS/EXPERIMENTS	Air & Water Pollution	Resources Recognition	Disaster Assessment	Biological Experiments	Levitation Experiments	Furnace Experiments	Small/Low Lemperature Exp.	OCCUPATIONAL SKILLS	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Optical Technician	Metallurgist Assistant	Surveyor, Geodetic	Chemist, Inorganic	Chemist, Physical	Physicist, Heat	Ceologist	Veophysicist	Weather Observer	Biochemist	Calibrator		Inspector, Systems Flectronics Mechanic
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2179 Landslide Disaster Predictor 2180 Snowslide Disaster Predictor	1	۲		\			+	-	l	H		-		<b> </b>		+			k		1			1	
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TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.

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2256   General Purpose Lab Bench Stower				$\vdash$		+	1	₹	1	┪	<b>∤</b> ∰		(3) (3)		헝			+	半	1				+	+	+		
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2259   Line Reader Installer						_	_/	4	1	I	1				8	1	Ŧ	Ţ	L	L	L	П	$\perp$	_	1	I	$\Box$	Ξ
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Z273   Calorimeter Inspector						$\Box$	_/	7		I				$\Box$	J		Ţ	L			П		$\downarrow$	1	Ţ	$\Box$	Q	X
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2275 Atmosphere Analysis Unit Inspector 2276 Chill System Inspector 2277 Heat Rejection System Inspector 2278 Heating/Positioning Coils Inspector 2279 Viewing Device Inspector 2280 VHF Power Unit Inspector 2281 Accident Control System Inspector 2282 General Purpose Lab Bench Inspector 2283 Environmental Chamber Tester 2284 Power Conditioning/Distribution System Tester 2285 Calorimeter Tester 2286 Friction Meansuring Device Tester		Friction Measuring Device Inspector		1	-	ा	- 1/2	\$	1	-	[]	H	1				1	+	†	Ť	H		_	_†-	+	$T^{I}$	ď	$\overrightarrow{\times}$
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2280 VHF Power Unit Inspector	2279	Viewing Device Inspector		Ħ	_	_†	-12	4		1	1 1	H	7	士	士	土	1	1			Ħ		士	士	1	Ħ	Ŏ	Ż
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2284 Power Conditioning/Distribution System Tester  2285 CalorImeter Tester  2286 Friction Meansuring Device Tester				-+	-+	+	-1/	オ	+	+		H	+	+	↲	+	+	+	+	╁╌	H	+	+	+	+	H	14	$\stackrel{\sim}{}$
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	2285	Calorimeter Tester			I	$\Box$	Z	V.	T		}		I		\$	I	I	I		L	П		I	T	I	П	$\Box$	_
[0]= Primary Occupational Skill. [X]= Mission Occupational Skill. [및 = Task-Skill Required by Payload/Experiment.			لبا	ᆛ	ᆛ	4		ــــــــــــــــــــــــــــــــــــــ	ㅗ	لسل	لسا	C		1	<u>ب</u> ک	_ـــ	ــــــــــــــــــــــــــــــــــــــ	١.	ــــــــــــــــــــــــــــــــــــــ	<u></u>	ᆜ	Ц			Щ.	لل		
	[0]= F	rimary Occupational Skill. $X = Mission Occupational Sk$	111.	K	<u>_</u>	=	ias	K-	٥k	111	Keq	uir	ed	by	/ P	ayl	080	d/l	×ţ	oer	ım	ent	•					_



TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills. (Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	Air & Water Pollution	Resources Recognition	Disaster Assessment	Biological Experiments	Furnace Experiments	Small/Low Temperature Exp.		OCCUPATIONAL SKILLS		Н		7	十	十	+	╁	Physicist Physical	╁	╁	╁╌	1	H	+	Inspector	Flectronics Mechanic
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2287 2288	Atmosphere Analysis Unit Tester Chill System Tester				4	- K	7		<b> </b> -		0		4	쑀	-	+	4								4	42	4
2290	Heat Rejection System Tester				7	7	1				Ŏ			Ì	T		1	+		+		1			1	1	
2291	Heating/Positioning Coil Tester				4		7				9			<b>X</b>	4		1		1						942 337	P	I
2292 2293	Viewing Device Tester VHF Power Unit Tester		H			Z		7 78			0	333		R	+		4	7	Ŧ			۳	137	H	242	+	+
2294	Accident Control System Tester		口	口	1		Ţ	I			Ŏ		1	\$	1	1	1	1	1	1	L			口	工	工	丰
2295 2296	Computer Tester Viewing Device Control Deactuator		Н	$\vdash \downarrow$	+	-K	4	+	+		2	$\dashv$	-	糾	+	+	+	+	+	+	╀	-	1-	$\dashv$	+	+	+
2297	Chill System Control Deactuator		Н		士	Ž	<u></u>	1				Ħ		XI.	1	1	T	T	T	$\perp$	1	$\vdash$	$\vdash$	$\Box$	_	十	+
2298	Crystal Growth Research Coordinator					Z	1		1				4		4	4	Ţ	$\mathbb{P}$	₫.				8			I	
2299	Crystal Growth Process Observer  Materials Sample Structure Analyzer		H			- /	1							+	8	1	+	*	4			-		2		+	1
2301	Metal Sample Structure Analyzer				1	Z	1							Ť	Ţ		1	1								1	
2302	Glass Sample Structure Analyzer				្រ	Z	7	Ļ				82	4		Ţ.	7	1	$\sum$	4						<u> </u>	Ŧ	F
2303 2304	Crystal Growth Research Monitor  Materials Dopant Translocator		Н	H	+	Ź	7	1	+	1	Н	+	-{	쐇	+	+	+	+	+	+	+-	-	-	$\vdash$	+	+	+
2305	Materials Dopant Unstower				1	Z	Ī	Ţ					1	Ø.	1	1	1	1	1	1				П	丰	丰	I
2306	Heating/Cooling Device Cleaner Heating/Cooling Device Control Deactuator		Н	$\vdash$	+	+	4	1	4		Н	-	{	<u> </u>	+	╀	╀	+	+	+	┼	-	Н	$\vdash$	-+	╁	+
2308	Sample Holder Remover					Ź	4	13	1		7		्रौ	Ž			1				1	Ng.	À.		3	1	1
	Composite Materials Research Coordinator						4	4				. 3			Š	4						3				I	I
2310	Dispersion Control System Translocator Dispersion Control System Installer						1/	#	1				$\dashv$	$\stackrel{\sim}{\downarrow}$		1							8			+	+
	Dispersion Control System Remover						Z	$\sqrt{\Delta}$			Ŏ			X											<b>2</b>	土	上
2313	Dispersion Control System Calibrator Composite Materials Sample Evaluator		H	$\vdash$	-	+	4	半	1		$\vdash$	4	4	- -	K	↲	+	+	╀	+	╁-	-		H	4	╁	¥
2315	Composite Materials Sample Evaluator  Composite Materials Research Monitor		H	+	+	+	扢	1	Н		Н	+	-	ম্	12	1	+	+	╁	╁	<del> </del>	Н	H	计	+	十	+
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<sup>&</sup>lt;sup>1</sup>General Technical Skill, 000.000, Assigned.

# WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

**CONTRACT NAS8-28359** 

FINAL REPORT

SECTION 4.0

DEVELOPMENT OF WORKSTATION CONCEPTS





#### SECTION 4.0

#### DEVELOPMENT OF WORKSTATION CONCEPTS

#### 4.1 GENERAL

This section of the report presents the results achieved in defining workstation concepts for two experiment areas. The areas selected, in common with the skills analysis portion of the study (see Section 3.0), were Earth Observations research, and Materials Sciences and Manufacturing research. No attempt was made to conceptualize a total facility for these research areas. The objective was to define the primary workstation for the experiment crew, i.e., the area with which the crew will interface most frequently and continuously, and which will be a primary driver to the orbital research facility layout.

The preliminary analysis which led to the selection of Materials Analysis experiments and Earth Observations experiments as subjects for this study is described in Section 2.0 of this report. Further, it was assumed that maximum value from the study would be realized if the task-skill/occupational skill analysis and the workstation concept development dealt with the same set of experiments and interfaces. The subject research areas, as a result, are designated Sortie Lab payloads, as follows:

## Earth Observations

EO-3: Air and Water Pollution EO-4: Resource Recognition

EO-5: Disaster Assessment

#### Materials Sciences and Manufacturing

MS-1: Biological Experiments

(1) Separation of Biologicals

MS-2: Levitation Experiments

(1) Preparation of Glasses

(2) Supercooling and Homogeneous Nucleation

(3) "Some" Crystals

MS-3: Furnace Experiments

(1) Composite Materials

(2) Directional Solidification

MS-4: Small and Low Temperature Experiments

(1) Physics of Fluids

(2) Zone Refining



#### 4.2 CONCEPT DEVELOPMENT APPROACH

# 4.2.1 Workstation Concept Development Criteria and Guidelines

The following general guidelines, constraints, and criteria were observed to the greatest extent possible:

- a) Equipment interfaces should reflect, both by their incorporation and location, the primary task dependencies identified in the Task/Skill Requirements analysis.
- b) When a specific item of experiment equipment could not be identified, either a "generalized" interface should be incorporated or a substitute with similar features should be used.
- c) Unless automation of a task was baselined, it was assumed that performance of the task would be accomplished manually, through direct interface by a crew member.
- d) Equipment and designs which were already qualified/accepted by NASA were to be used as much as possible.
- The approach utilized should be common for all Sortie Lab payloads/ missions.
- f) The workstation should be compatible with single-crewman or multiplecrewmen operation, depending on the requirements of a specific experiment.
- g) The concept should promote rapid between-mission turnaround of the Sortie Lab module.
- h) The workstation should be compatible with other functions and activities in the Sortie Lab and the Shuttle Orbiter.

#### 4.2.2 Conceptual Approach to Sortie Lab Workstation Development

In an attempt to satisfy the majority—and most significant—of the above guidelines, it was determined that the "workstation" for Sortie Lab research activities should be an integrated Control and Display (C/D) console. While such a console could not be expected to incorporate all possible C/D interfaces with the experimenter, across all Sortie Lab missions, it could be adequate for the majority of such interfaces. With the proper approach, such a console could permit single or multiman operation, could provide for rapid turnaround, could be efficiently reconfigured for incorporation of new experiments, and could be compatible with nonexperiment considerations of the Sortie Lab and the Shuttle Orbiter. This was achieved, conceptually, by determining that the integrated C/D Console would contain separate areas for functions relating to Sortie Lab Module Subsystems, subsystems in support of experiment payloads in general, and equipment which was specific to a particular set of payload experiments.



## 4.2.3 Derivation of Control/Display Functional Requirements

Having decided on a general approach to arriving at an integrated control/display console for Sortie Lab payloads, an analysis was conducted to determine the functional requirements for control and display of Earth Observations and Materials Sciences experiment operations. This was accomplished for each item of experiment equipment identified as a primary task dependency in the skills analysis portion of the study, and for some of the secondary task dependencies as well, when appropriate to development of C/D requirements. The most current descriptions available of the equipment items were used as references for functional characteristics and configuration, some from Sortie Lab documentation, and some extending as far back as the January 1971 Blue Book, and Skylab. An example of the Control/Display requirements analysis is included as Figure 4-1; documentation for the total analysis is in Appendix G.

Concurrent with this effort, other URS/Matrix studies were directed toward identifying control/display functional requirements for Sortie Lab Module and Payload Supporting Subsystems. The two efforts were merged to arrive at a more complete integrated C/D console concept. One of the results of this interfacing of the two studies is that experiment control/display requirements which were determined to be required by many payloads, in a large number of disciplines, were assigned to the Payload Support portion of the console, and were not repeated in the Experiment Support portion of the console.

### 4.2.4 Requirements Allocation and Concept Definition

Figure 4-2 illustrates the conceptual approach to this C/D Console, which has the following characteristics:

- A Sortie Lab "Module Support Subsystems" C/D Panel area. This portion of the workstation is essentially independent of the type of Sortie Lab missions being flown and would require no payload-related configuration changes between Sortie Lab missions. The crew interface is primarily a monitoring task, once initial activation of subsystems has been accomplished.
- A Sortie Lab "Payload Support Subsystems" C/D Panel area. This portion of the workstation comprises the central operations area for a payload specialist. Requirements analysis has indicated that some payload-related control/display requirements are common to almost all anticipated Sortie Lab missions, regardless of the nature of the experiments in the specific payload. These functions have been grouped in the central console area and, like the "Module Support Subsystems" portion of the console, they would not require interchange during Sortie Lab turnaround.
- An area below the workshelf which has the data processing equipment, electronics that need not be "behind the panel", and the central computer. These are in pull-out drawers for easy access. Figure 4-3 illustrates front and side views of the "fixed" module/payload supporting subconsole.



SORTI	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS	•	ANALYSIS		SUBSYSTEM/EXP: Mater	Materials Sciences (Continued)
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
E-01	Continuous Atmosphere Analysis Apparatus	MS-2	2,3	Power Chromatograph on/off Spectrometer on/off	Power on Chromatograph operating status Spectrometer, operating status Impurity count	
E-02	High Temperature Viewing Device	MS-2	м	Power Laser on/off Display adjust. Photograph actuate	Power on Laser oper. status Holographic display	
E-03	Chill System	MS-3	. 2	Power On/off Cooling/Coding Jet select	Power on Operating status Cooling/Cooling Jet select status Cooling Jet Warning Pump status	<ul> <li>Movable unit for multiple location use; may not be susceptible to centralized C/D.</li> <li>May require audible alarm.</li> </ul>
E-04	Motion Picture Camera (16mm)	MS-2 MS-3 MS-4	7 2 1,2	Power On/off Lens changing Focus adjust	Power on Operating status Lens in use Focus in use	<ul> <li>Electrically operated</li> <li>Multiple cameras planned</li> <li>Moyable; C/D centralization</li> <li>difficult.</li> </ul>
E-05	TV Camera	MS-1 MS-2 MS-3 MS-4		Power On/off Focus adjust	Power on Operating status Focus Video monitor	<ul> <li>All notes same as E-04</li> <li>Pan/tilt provisions unknown.</li> </ul>
E-06	Remote Measuring (Mass, Dimensions) MS-2 MS-3		1,23	Power On/off	Power on Operating status	<ul> <li>Description unavailable;</li> <li>believed to be the device for illuminating/reviewing holograms made with E-02.</li> </ul>

Figure 4-1: Example of Control/Display Functional Requirements Analysis



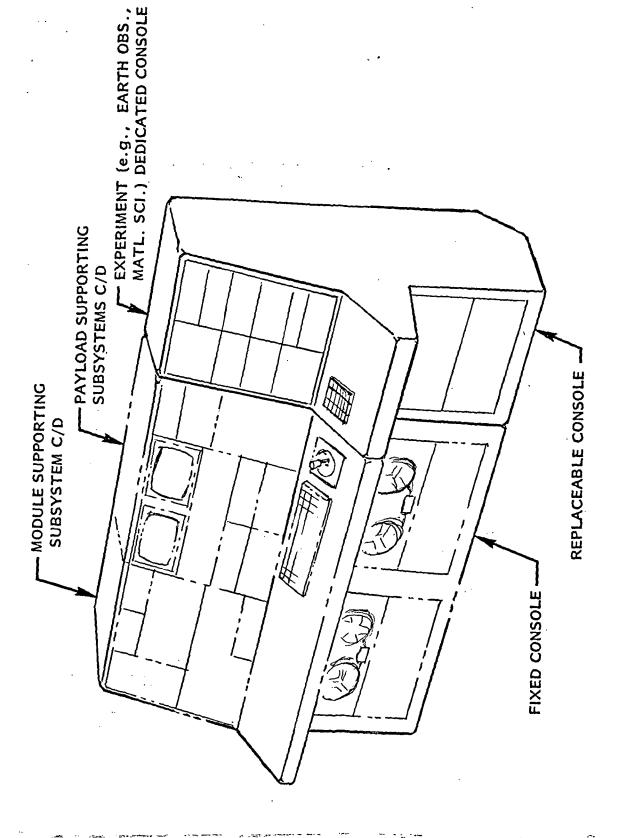
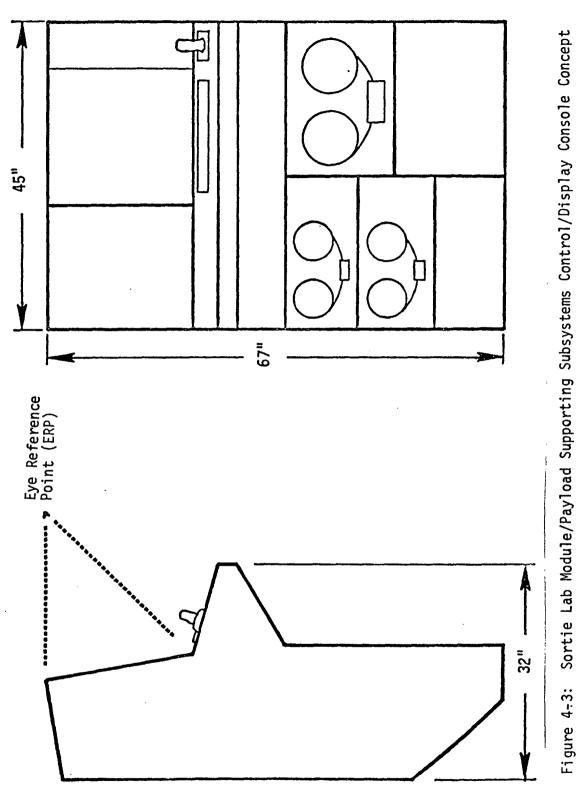


Figure 4-2: | Conceptual Approach to Sortie Lab Workstation Design





4-6



A separate, but physically and functionally compatible, "Experiment Support Subsystems" C/D Panel area. This subconsole is specific to the scientific/technical disciplines of the experiments comprising the payload, containing those controls and displays for experiment operations and monitoring which are amenable to incorporation in a centralized console; which have fairly common applications to experiments within the discipline; and which are not incorporated in the "Payload Support Subsystems" subconsole. This subconsole will be easily detachable from the remainder of the workstation for interchange during the between-mission turnaround.

This concept appears to represent the most feasible approach to providing centralized control and display of Sortie Lab functions, within the constraints of limited new hardware development, rapid turnaround between flights, and variable crew size and composition. It also is a realistic compromise between the competing desires of some for a totally "dedicated" C&D console, and of others for a completely "universal" C&D console. Dedicated consoles are too dependent on long-lead time training for specific individuals, and show too little between-mission commonality. A universal console is not feasible at present, primarily due to costs and unnecessary weight. Certain items of experiment-related equipment (e.g., Cloud Physics experiment) would not be represented on the consoles, if they were determined not to be amenable to a centralized console. This determination was made in the experiments analyzed whenever the experiment requirements dictated a direct physical or visual interface between the crew member and the experiment operation.

A special analysis was conducted to determine the requirements for a "workbench" as part of the Sortie Labs workstation. It was determined that while a workbench might prove useful, particularly in Materials Sciences experiments, there is no significant requirement that one be provided. This decision was reached after considering the guidelines for Sortie Lab missions, comprising little or no on-board maintenance and minimal in-flight configuration changes to equipment. The conclusion drawn from this preliminary analysis was that any requirements for a separate work surface could be met by a small, fold-down type shelf. Lengthier mission durations, with greater requirements for maintenance, repair, or configuration changes will probably require a separate workbench area. It should be noted, however, that the Task/Skill Requirements analysis for Materials Science experiments does specify the utilization of the General Purpose Lab Bench (Task Dependency #4.D.22-1) and provision is made for a C/D interface to it on the Materials Sciences subconsole (see paragraph 4.5).

# 4.3 MODULE/PAYLOAD SUPPORTING SUBSYSTEMS C/D CONSOLE\*

Certain functions were identified in the analysis as being control/display requirement drivers. Those identified for the Module Supporting Subsystems portion of the console are listed in Table 4-1; those for the Payload Supporting Subsystems portion of the console are as follows:

<sup>\*</sup>The data presented in this paragraph and in the applicable portion of Appendix G are the result of joint effort studies, performed partially under this contract and partially by other URS/Matrix studies.



Table 4-1: Module Supporting Subsystem C/D Requirements

FUNCTION	C/D REQUIREMENTS
Caution and Warning	<ul> <li>Attitude Control System</li> <li>Power</li> <li>Temperature</li> <li>Pressure</li> <li>Contamination</li> <li>Radiation</li> <li>Acceleration</li> <li>Airlock Status</li> </ul>
Data Management	<ul> <li>Digital Address System</li> <li>Telemetry</li> <li>Orbiter Interface</li> <li>Voice/Video Recorders</li> </ul>
Communications	<ul> <li>Voice</li> <li>Command</li> <li>Experiment Data</li> <li>Computer Data</li> <li>Video</li> </ul>
Power	<ul> <li>Lighting, Thermal, etc.</li> <li>Fuel Cell/Battery, Regulators</li> <li>C&amp;D Console</li> <li>Experiment Console</li> <li>Experiment Subsystems</li> </ul>
Lighting	<ul><li>C&amp;D Console</li><li>Experiment Console</li><li>Lab</li></ul>
Attitude/Stability Control	<ul> <li>Shuttle Orbiter Monitor</li> <li>Experiment Platform</li> <li>CMGS</li> <li>Star/Sun Tracker</li> </ul>
EC/LS	<ul> <li>Thermal</li> <li>Pressure</li> <li>Space Radiator Deployment</li> <li>Contamination</li> <li>Humidity</li> </ul>

A control/display requirements analysis was performed on the above supporting subsystem; resulting data are presented in Appendix G.



# PAYLOAD SUPPORTING SUBSYSTEMS REQUIREMENTS

- Data Analysis/Storage
- Mission Time
- Event Time
- Orbit Time

- Manual Pointing Control
- Airlock/Boom
- Experiment Stability
- Video Monitors

Translation of these control/display requirements, for the Module Supporting Subsystems and the Payload Supporting Subsystems, resulted in the specification of definitive control/display characteristics, as itemized in Appendix G. The resulting panel layouts are illustrated in Figure 4-4.

Special mention should be made regarding the fact that Module Support and Payload Support subconsoles are permanently joined in this concept. This is primarily for ease of assembly, and to reduce the number of subconsole interconnections. If Support Module design considerations dictate that only two of the three subconsoles can be placed side-by-side, it would be preferable to have a parting plane between the Module Support and Payload Support subconsoles, and relocate the Module Support portion. It is much more necessary that the Payload Support and Experiment Support subconsoles be located together, since both are required for experiment operation.

#### 4.4 EARTH OBSERVATIONS EXPERIMENT SUPPORT CONSOLE

An analysis was conducted of the control/display requirements for experiment equipment during Earth Observations missions. These C/D requirements are itemized in Appendix G, and they include all documented Sortie Lab EO missions. Certain C/D requirements were satisfied by incorporation in the Payload Supporting Subsystems C/D Console Panel, if high commonality with other experiment areas could be demonstrated. Other C/D requirements were so specialized (or so unique as to dictate against their incorporation into a centralized console) that they were excluded. In this latter case, it is expected that the necessary controls and displays will be on the item of experiment equipment itself, if appropriate.

The Earth Observations Experiment Support Console Panel configuration which resulted from this analysis is illustrated in Figure 4-5. Integration of the EO subconsole with the Module/Payload Support console is illustrated in Figure 4-6. Supporting analytical data, in terms of functional requirements for controls and displays during Earth Observations Sortie Lab missions, are in Appendix G. All panel features identified have been given a task dependency reference code number. The format and utilization of the task-dependency reference system is explained in Section 2.0. The complete Task Dependency Reference List is incorporated as Appendix D to this report. Earth Observations C/D task dependencies are in the 2.B.04 series of Appendix D. A cross-reference between EO experiment equipment, C/D panels, and experiments, is included in Appendix G.

# 4.5 MATERIALS SCIENCES EXPERIMENT SUPPORT CONSOLE

Similarly to the Earth Observations workstation concept development (paragraph 4.4), an analysis was performed to determine the requirements for experiment equipment controls and displays during Materials Sciences and



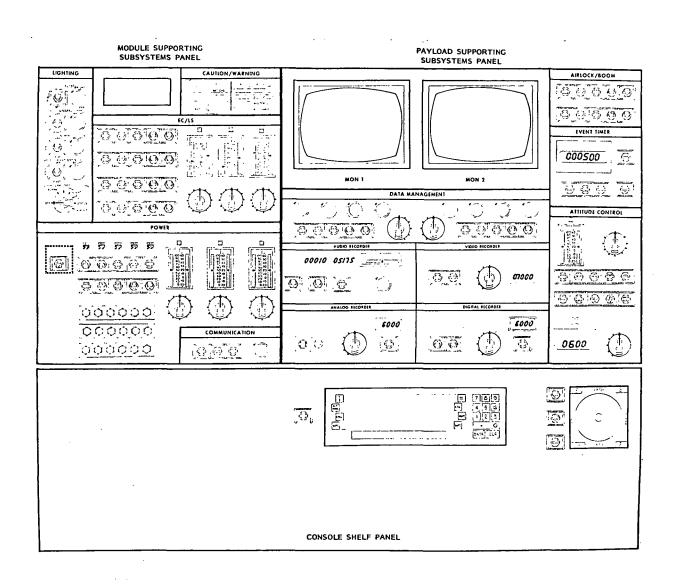


Figure 4-4: Sortie Lab Module Supporting Subsystems/Payload Supporting Subsystems Control/Display Console Panel Concept



# EARTH OBSERVATIONS EXPERIMENT SUPPORT

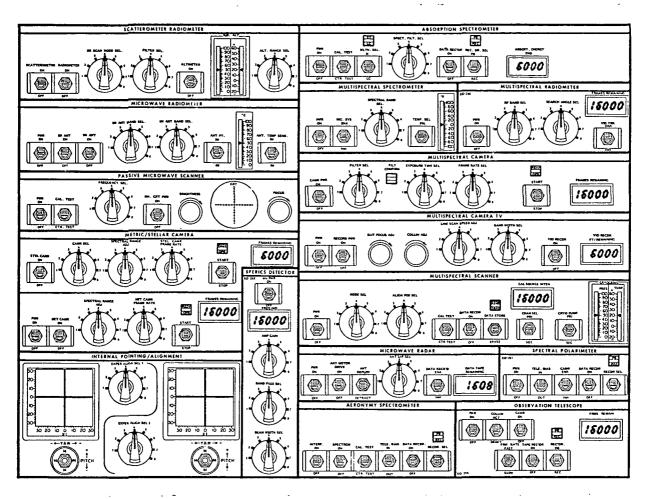
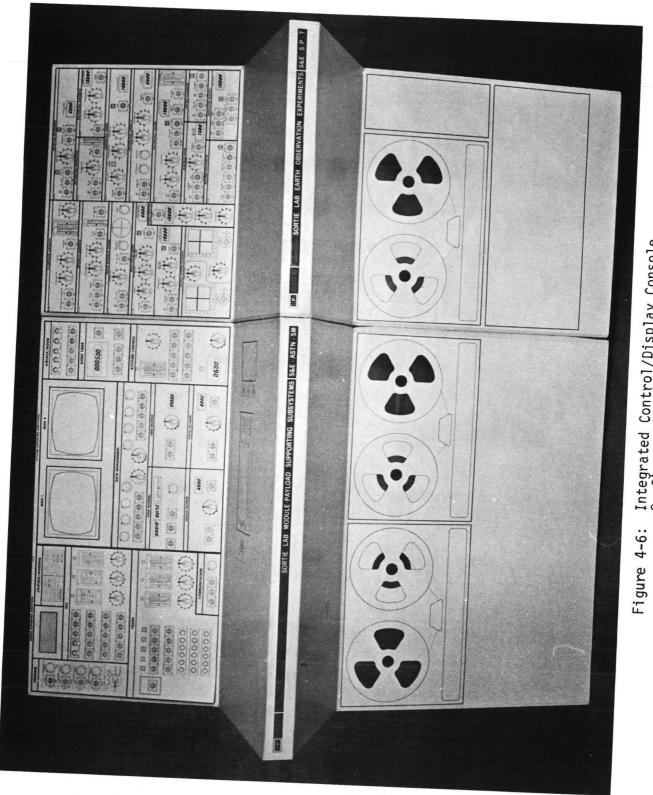


Figure 4-5: Experiment Support Control/Display Console Concept, Earth Observations



: Integrated Control/Display Console Configured for Earth Observations Missions



Manufacturing missions. These C/D requirements are itemized in Appendix G. and include all projected Materials Sciences Sortie Lab missions (and equipment) about which definitive information was obtained. Some functional requirements were satisfied by features of the module-supporting and payloadsupporting console, as was the case with the EO requirements. A fairly large number of MS C/D requirements were determined to be best satisfied by having controls and display features directly on the equipment rather than on the integrated console. This generally was true when the equipment required a direct interface with the experiment, or when the equipment was estimated to be included only on an infrequent basis on Sortie Lab missions. Although it is a subjective decision at this point in time as to which items of equipment will be flown most frequently, the decision is not critical to the "concept" of an integrated MS Experiment Support C/D Console. The panel layout which resulted from those study efforts is illustrated in Figure 4-7. Integration of the MS subconsole with the Module/Payload Support Console is illustrated in Figure 4-8. Although not depicted on this layout drawing, each panel and feature thereon has been coded into the Task Dependency Reference System (Appendix D, series 2.B.06), in addition to all other C/D features whether or not they were not incorporated in the panel concept. A cross-reference between MS experiment equipment, C/D panels, and experiments, is included in Appendix G.

#### 4.6 INTEGRATED CONSOLE CONCEPT VALIDATION

After the preliminary requirements analysis for all portions of the proposed consoles (Module Support/Payload Support/Experiment Support) were completed and preliminary panel layouts were prepared, it was appropriate to prepare full-size, soft mockups of the integrated consoles to determine concept validity. This also provided a more satisfactory visualization of the overall console configuration and the demands that this approach might place on overall Sortie Lab workspace. The finalized design concept configurations are illustrated in Figures 4-6 and 4-8. A sketch of the manner in which the integrated console might be included in Sortie Lab is shown in Figure 4-9. Inasmuch as there were no firm dimensional constraints regarding the length of the Sortie Lab module, the proportionality shown in Figure 4-9 must be regarded as an estimate.

#### 4.7 GENERAL SUMMARY OF WORKSTATION CONCEPTS DEFINITION

The concepts presented in this section of the report provide a reasonable approach to promoting safe, efficient, and effective performance by an experiment crew in controlling, monitoring, and evaluating the conduct of Sortie Lab research while on orbit. Guidelines and constraints identifiable during the study affecting Sortie Lab definition have been observed, and are reflected in the console configurations. The actual layouts, dimensions, and/or assignment of C/D functions on the consoles must, of course, be regarded as estimates and general projections. Actual equipment to be utilized, experiments to be conducted, and combinations of payloads to be orbited are still being defined in the many studies being performed by NASA and its outside contractors. Nevertheless, it is believed that the approach followed in this study represents an important first step in defining Sortie Lab control/display requirements — and feasible approaches to their resolution — based on the needs of mission crews which must utilize them.



# MATERIALS SCIENCES EXPERIMENT SUPPORT

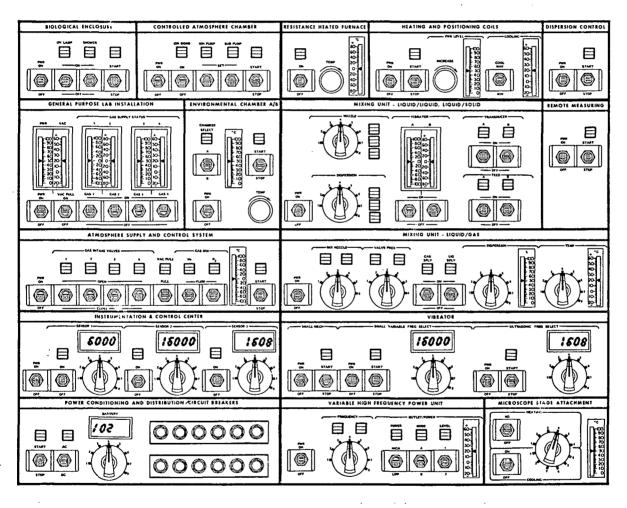


Figure 4-7: Experiment Support Control/Display Console Concept, Materials Sciences

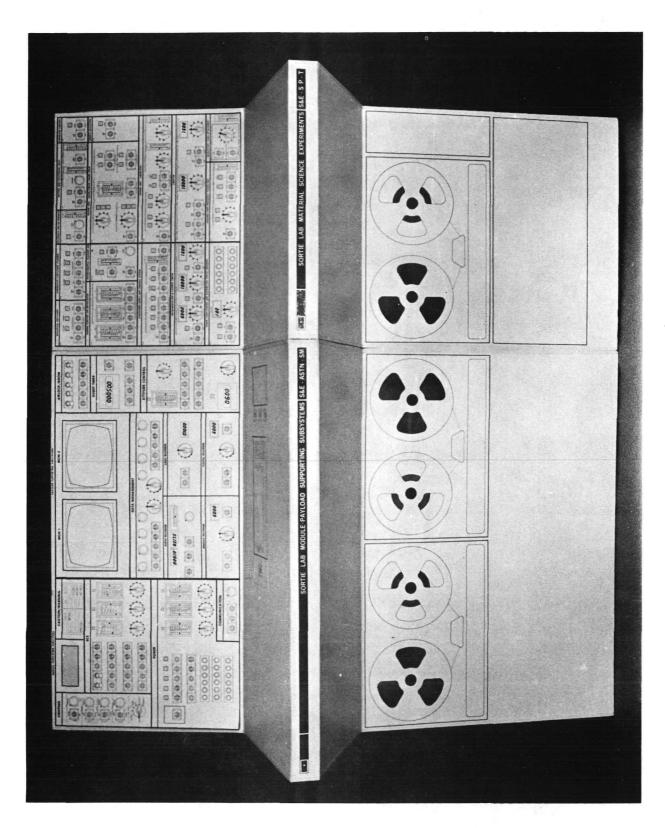
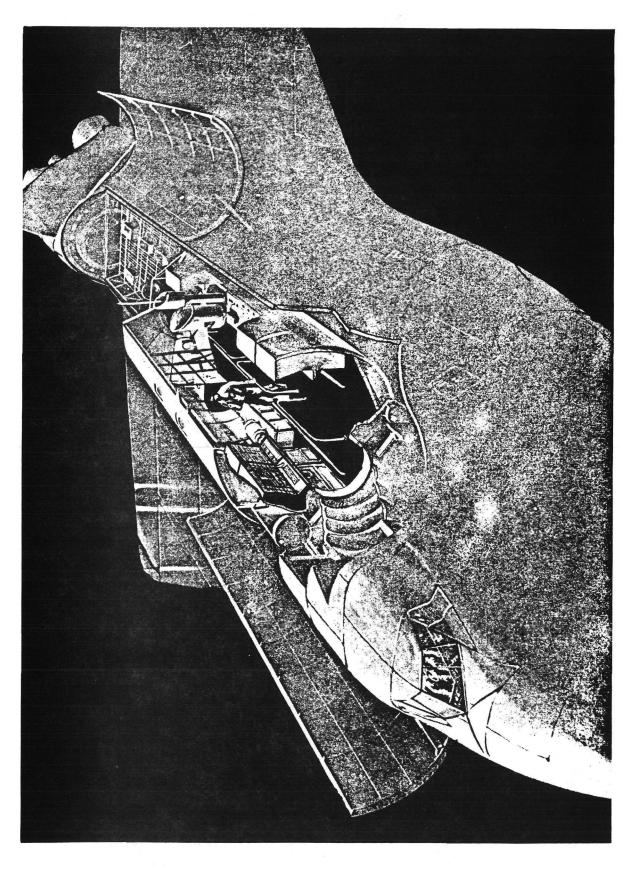


Figure 4-8: Integrated Control/Display Console Configured for Materials Sciences Missions



# WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

CONTRACT NAS8-28359

FINAL REPORT

SECTION 5.0
SUMMARY AND CONCLUSIONS





## SECTION 5.0

# SUMMARY AND CONCLUSIONS

### 5.1 GENERAL SUMMARY

The study presented in this report was performed by the URS/Matrix Company, Man Systems Division, under the sponsorship of NASA's Marshall Space Flight Center (Contract NAS8-28359). The three primary objectives which had been established for the program were achieved, to wit:

- Definition of the scientific and technical task performance requirements and capabilities needed in support of two areas of orbital research (Materials Sciences and Earth Observations) as projected for early Sortie Lab missions;
- (2) Development of concepts for Sortie Lab experimenter workstations for these two research areas, thereby providing experiment crewmen with an efficient and effective interface with the systems and equipment which must be operated;
- (3) Revision, updating, and expansion of the task requirements and skill requirements data base originally developed under Contract NASw-2192.

# 5.2 SKILL REQUIREMENTS ANALYSES

The analyses of requirements for task performance capabilities needed by orbital research crewmen in support of Sortie Lab Earth Observations and Materials Sciences payloads have resulted in the identification of 820 different task-skills, twenty one (21) different Primary Occupational Skills, and five (5) different Mission Occupational Skills. The allocation of these skill assignments to the various experiments and payloads studied is shown in Table 5-1.

Although the numbers in this table are not very descriptive of the kinds of skills which may be required, they do indicate the breadth of capabilities needed at the Task-Skill level, but with a fairly narrow range of capabilities needed at the Mission Occupational Skill level. More significant, perhaps, is that the extensive commonality which exists at all skill levels, even between these two very different areas of research, indicates that mixed payloads are a very feasible option, at least from the standpoint of skills. If it can be determined that such commonality extends to other payloads and disciplines not covered by the present study, objectively derived skill requirements can legitimately take their place alongside engineering requirements as valid "drivers" in payload definition studies. With such flexibility (available in the crew resources when the requirements are identified in advance) a mixed payload may often provide a more satisfactory engineering solution than can be achieved with a single-discipline payload, especially when "suitcase" experiment add-ons are being considered.



Allocation of Skill Requirements to Sortie Lab EO and MS Payloads TABLE 5-1:

		TA	TASK-SKILLS*	*S*	PR 00 SK	PRIMARY OCCUPATIONAL SKILLS*	IAL	M. SK	MISSION OCCUPATIONAL SKILLS*	NAL
	PAYLOAD/ EXPERIMENT	SPECIFIC DISCIPLINE-	DISCIBFINES BELMEEN COWWON	JATOT	Sbecilic Discibline-	DIZCIbrinez BELMEEN COWWON	JATOT	SPECIFIC DISCIPLINE-	DIZCIBFINEZ BELMEEN COWWON	JATOT
E0-3 Air	r & Water Pollution	145		156	7	7	14	_	2	m
E0-4 Re	Resource Recognition	137	7	144	7	9	13	_	2	m
E0-5 Di	Disaster Assessment	252	12	264	8	7	15	-	2	က
TOTAL E.	EARTH OBSERVATIONS	324	14	338	6	7	16	l	2	3
MS-1(1)	Separation of Biologicals	112	9	118	1	7	8	Ļ	2	3
MS-2(1)	Preparation of Glasses	156	6	165	-	7	8			
MS-2(2)	Supercooling	211	2	224	2	7	6			
MS-2(3)	Crystals Growth/Solution	152	5	157	_	7	8			
SUBTOTAL:	L: LEVITATION EXP. (MS-2)	276	6	285	2	7	9	2	2	4
MS-3(1)	Composite Materials	129	-	130		9	7			
MS-3(2)	Liquid Dispersions	155	11	166	-	9	7			
SUBTOTAL:	L: FURNACE EXP. (MS-3)	198	11	209	-	7	8	l	2	3
MS-4(1)	Fluid Convection	127	11	138	2	7	6			
MS-4(2)	Crystal Growth/Melts	153	11	164	_	7	8			
SUBTOTAL:	L: SMALL/LOW TEMP (MS-4)	215	11	226	3	7	10	<b>,</b> -	2	3
TOTAL M	MATERIALS SCIENCES	481	14	495	2	7	.12	2	2	4
	GRAND TOTAL	805	14	618	14	7	12	3	2	5
1 1										

\* Not additive vertically



Examination of the data in Table 5-1 makes it clear that no payload, of those studied, will require more than four (4) Mission Occupational Skills, and most require only three (3). While it is again emphasized that this refers to <a href="mailto:skill">skill</a> complements, and not numbers of crewmen, it is also valid to conclude that the planned crew sizes of four (4) personnel for Sortie Lab are probably realistic. Much work remains to be done in timeline analysis, workloads analysis, etc., but the matching of skills to the number of available crewmen appears more feasible than if the skill complement requirements exceeded the number of crewmen available.

To keep these results in perspective, of course, it must be remembered that the skills identified herein are not all inclusive. The method used to determine these requirements should be considered a "sampling" technique which, in the composite, will identify the tasks, interfaces, and skills needed in support of a particular experiment or payload.

Notwithstanding the importance of defining specific skill requirements for specific projected missions, an equally significant outcome of this study is the demonstration that it can be done. It has been shown that the elements which dictate a need for particular personnel resources can be objectively determined, that these elements can be combined into valid predictions of requirements for specific skills, and that the sources of these skills are identifiable to specific occupational and professional descriptions.

# 5.3 DEVELOPMENT OF WORKSTATION CONCEPTS

A requirements analysis, conducted to enable definition of feasible and effective experiment workstations for Sortie Lab, led to the selection of an integrated Control/Display Console within the Sortie Lab Module. For a given mission and payload, the integrated console would have three functionally different segments:

- (1) Module Supporting Subsystems C/D Console
- (2) Payload Supporting Subsystems C/D Console
- (3) Experiment Support C/D Console

Two of these "subconsoles" (Module Supporting and Payload Supporting) would be permanently joined in a common console frame and would remain in the Sortie Lab at all times, including between-mission turnaround. It could, of course, be removed if major reconfigurations of the total facility were needed, or if a complete breakdown should occur, and it could be replaced by another similar console. Normal between-mission maintenance and reconfiguration (if needed) would be accomplished with the console in place in the Sortie Lab Module.

The third segment of the integrated console (Experiment Support) is specific for each type of payload, and would be interchangeable between Sortie Lab missions. This subconsole would exist in a number of variations, each designed to support a particular area of research and all compatible with the



remainder of the integrated C/D console — both physically and functionally. Thus, the benefits of "dedicated" C/D consoles are available without their associated high costs to the total program. Likewise, between-mission downtime is minimized, and the major portion of the console is standardized, regardless of the type of research being conducted. Interconnection of the "permanent" and "interchangeable" portions of the console, as well as the interconnection of those two parts with their associated subsystems/equipment, would be accomplished through maximum utilization of plug-in cables and modules, data busses, etc., to keep changeover difficulties to a minimum.

# 5.4 PRINCIPAL OUTPUTS OF THE STUDY

This study, <u>Development of Flight Experiment Work Performance and Work-</u>
<u>station Interface Requirements</u>, has resulted in the following principal outputs:

- Definition of specific skill and personnel resource requirements for two areas of scientific research (Earth Observations and Materials Sciences) related to Sortie Lab missions -- See Section 3.0.
- A concept for an integrated control/display console for Sortie Lab missions -- See Section 4.0.
- Conceptual designs for two experiment support subconsoles (Earth Observations and Materials Sciences) for planned Sortie Lab missions -- See Section 4.0.
- Definition of control/display functional requirements related to Sortie Lab missions -- See Appendix G.
- Definition of estimated costs for control/display components covered by the derived concepts -- See Appendix G.
- A comprehensive listing of experiment equipment and other interfaces upon which successful crew performance depends -- See Appendix D.
- A taxonomy of crew functions related to on-orbit research and applications, with complete definitions -- See Appendix B.
- A documented task-skill analysis of eleven (11) experiment areas in two disciplines defining tasks to be performed, interfaces, and skill requirements -- See Appendix H.

# 5.5 CONCLUSIONS AND RECOMMENDATIONS

This study represents an initial effort toward providing quantified projections of the scientific and technical human resources that will be required for a sizable portion of future NASA programs, permitting such factors to become "design drivers". This is definitely required for future programs, especially in view of severely constrained program development budgets, in order to take maximum advantage of available skills and knowledge; to reduce long lead time, mission-specific training; to eliminate equipment redesign which would otherwise be required to achieve man-equipment interface



compatibility, and to preclude most of the operational errors which occur when design is "frozen" without reflecting the capabilities of the personnel who are likely to be operating the equipment.

As a result of this study, it is concluded that:

- a. It is feasible to identify skills required of crew members early in the definition phase of development programs. It is neither necessary nor appropriate to wait for complete definition of equipment, facilities, or objectives prior to initiating a skill requirements analysis.
- b. Assessment of skill requirements can and must be based on an objective evaluation of the activities and tasks which personnel may be required to perform. The assessment should be at as detailed a level as is possible considering the status of program definition. Subjective evaluations which result in instant "skill requirement" specification should be avoided. Such an approach is invalid, and it can be misleading to mission planners. When subjective evaluations are used to develop prime crew skill complements, an infinitely large and varied population of skilled personnel must be available, at the experiment site, to compensate for the planning oversights which inevitably occur.
- c. Determination of skill requirements at the elemental level, i.e., Task-Skills, will permit crew complements to be partially structured as a direct output of timeline analysis. This is true since each element in a detailed timeline analysis will have one or more identified task-skills already associated with it. Appropriate use of automatic data processing and sorting methods will provide immediate identification of conflicts between requirements for and availability of specified skills.
- d. Workstation planning and preliminary design can be accomplished using preliminary human performance requirements and capabilities data as design drivers, as is evidenced by the workstation concepts documented in this report.
- e. A method is available for utilization of skill requirements information as an aid to experiment and mission planners in making decisions regarding configurations, policy, procedures, and objectives. It is hoped that this method will be widely utilized in concert with other valid decision criteria, since man's flexibility as a system element, while broad, is not limitless.

# DEVELOPMENT OF FLIGHT EXPERIMENT WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

CONTRACT NAS8-28359

FINAL REPORT

APPENDIX A

BIBLIOGRAPHY OF REFERENCE PUBLICATIONS





# APPENDIX A

# BIBLIOGRAPHY OF REFERENCE PUBLICATIONS

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# DEVELOPMENT OF FLIGHT EXPERIMENT WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

**CONTRACT NAS8-28359** 

**FINAL REPORT** 

APPENDIX B

DEFINITIONS OF FLIGHT EXPERIMENT CREW FUNCTIONS

AND

CREW FUNCTIONS





### APPENDIX B

## DEFINITIONS OF FLIGHT EXPERIMENT FUNCTIONS AND CREW FUNCTIONS

# MAJOR FUNCTIONS@

SHUTTLE FLIGHT (F) FUNCTIONS: These functions are basically independent of the nature of the R&A mission, except as they affect orbit selection, etc. All operating functions are the responsibility of the flight crew. The experiment crew members, if present, will be impacted in their roles as passengers and will have habitability tasks to perform.

RESEARCH AND APPLICATION (R) FUNCTIONS: These are functions directly related to the R&A mission, and they will show wide variation depending on the FPE or experiments being flown. All functions are the responsibility of the Experiment Module (EM) crew, or, in certain instances, the flight crew\*. The functions have in common the performance of experiments in orbit and the activities which must take place preceding and subsequent to that performance.

SERVICING (S) FUNCTIONS: These functions are related to the R&A missions, and may be the responsibility of the EM crew or the flight crew, depending on type of mission. These functions will be included in all missions except Mission Mode A, Type 2. The servicing functions deal with maintenance, repair, and replacement of experiment equipment.

HABITABILITY (H) FUNCTIONS: These functions are basically independent of the nature of the R&A mission, and are superimposed over all other functions to ensure the safety, comfort, and survival of the crew members. All crew members will be involved in these functions.

REMOTE CONTROL (D) FUNCTIONS: These functions are the responsibility of the ground control team or a Space Station team, and deal with automatic or remotely controlled conduct of experiments. It is possible that an Orbiter flight crew may act in the capacity of remotely controlling the experiments in Mission Mode A, Type 2, but no information is presently available pertaining to this possibility.

<u>Summary</u>: Basic function descriptions for Major Functions R and S follow, and the study is based on further breakdown and definition of those functions.

<sup>@</sup>See Reference 68.

<sup>\*</sup>On servicing missions or automatic missions, there may be no separate  $^{\rm EM}$  crew, in which case the flight crew has this responsibility.



# BASIC FUNCTIONS

# O1 DEPLOY EXPERIMENT MODULE (EM)

This function may be the responsibility of the EM crew\*, the flight crew, or both together. Deploying the module will be primarily automatic and will be initiated from the orbiter command area. Crewmen will monitor, through use of visual observations (instruments, TV, etc.), the progress of the deployment. In most cases, this will consist of opening the payload hatch doors, extending the RAM outside the orbiter envelope, and bringing it to the appropriate attitude for either experiment conduct or detachment. In some cases, the EM may stay within the payload bay, so only the opening of the payload hatch doors is involved.

Manual override of the automatically controlled process will be possible in case problems of deployment threaten the integrity of the spacecraft.

Major subfunctions are:

- Secure spacecraft (orbiter, etc.)
- Self-test deployment systems
- Open payload hatch
- Initiate deployment sequence
- Monitor deployment progress
- Inhibit deployment sequence (in case of fault)

Some EM-specific variations may exist, but crew tasks should be very similar for all missions. The shirtsleeve environment is envisioned for all currently anticipated missions.

# 02 STOW EXPERIMENT MODULE (EM)

This function may be the responsibility of the EM crew, the flight crew, or both, depending on the type of mission. In any case, it will be primarily automatic. All constraints, conditions, and subfunctions should be as in Ol (DEPLOY EM), but reversed.

Normally, this function will be performed only when the mission is completed and the EM/Orbiter combination is to be returned to earth. In addition, it may be required when the mission cannot be completed due to equipment malfunction, personnel illness, etc., and the deficiency cannot be corrected in orbit.

# 03 TRANSFER CREW TO EM/SSM

This function is the responsibility of the EM crew\*, with the flight crew monitoring progress and providing some general support. The transfer will be

<sup>\*</sup>On servicing missions or automatic missions, there may be no separate EM crew, in which case the flight crew has this responsibility.



manual in all envisioned missions and will be comprised of the EM crewmen opening the airlock hatch to the EM or SSM, passing themselves and their belongings through the passageway into the module. Some configurations may require a pressurization sequence prior to entry. Others may require the translation to be made in full pressure suits (e.g., if EM is not habitable).

On Shuttle-sortie missions, there should be very little cargo transfer involved, limited primarily to the personal belongings which the EM crew members carry with them in the Orbiter. (All experiment equipment will normally be stowed in the EM or SSM before luanch.)

On servicing missions, cargo transfer requirements will be much lighter, since fresh logistics supplies, spare parts, tools, and perhaps new/additional instruments will be transferred.

# Major subfunctions:

- Pressurize EM (if required)
- Self-test EM/SSM habitability
- Open airlock(s)
- Transport self and cargo thru passageway
- Secure airlock(s)

# 04 EXPERIMENT SETUP

This function is the responsibility of the EM crew. Depending on the nature of the FPE and the extent to which experiment equipment and instrumentation has been secured/stowed for launch and ascent, this function may be either very simple or very complex. The simplest mission will be that where all equipment is prelocated in its operating position or is deployed automatically. A self-test and calibration sequence will probably be initiated (this could be done from the orbiter or ground, not requiring the EM crew in the module), and if everything is in order, no further EM crew tasks exist in this function.

At the other extreme, where man is a direct participant in the experiment (either as controller, subject, or both), the EM crew will determine which experiments are to be conducted, select appropriate equipment, assemble the experiment equipment arrays, deploy them as appropriate, and perform test and checkout for proper operation. The process may be repeated many times, depending on duration of the flight, experiment results, and other similar factors.

The environment in which this function is performed may likewise show wide variation. In most cases, this should be a shirtsleeve environment; in some cases it will be IVA, requiring full pressure suits; in a few cases (e.g., where instruments must be mounted on the exterior surface of the EM), EVA may be required. Details regarding IVA and EVA requirements are quite limited, but these modes must be anticipated.



Major subfunctions are:

- Determine experiments to be run (A/R)
- Select experiment equipment (A/R)
- Assemble experiment equipment
- Deploy experiment equipment
- Test, check out, calibrate, align, etc., experiment equipment
- Initiate experiments

# 05 EXPERIMENT SHUTDOWN

This function will normally be the responsibility of the EM crew. Exceptions would occur when the experiments are to be totally automated, when controlled remotely from ground or Space Station, or when the mission is to be of the servicing type with this function being designated to the orbiter flight crew.

The function will be performed at the completion of a sequence of experiments, at the completion of the orbital mission, or for purposes of performing scheduled or unscheduled maintenance. The nature of the function is typically the reverse of 04 (EXPERIMENT SETUP), although there should be little requirement for judgmental decisions. In addition, depending on the reason for shutdown, the function may consist only of temporary deactuation or may require complete shutdown, packaging, and stowage of equipment and data. The skills required will be largely mechanical skills.

Major subfunctions are:

- Determine experiments to be shut down (A/R)
- Deactivate operating equipment
- Disassemble equipment arrays
- Retrieve data held by equipment
- Package equipment for stowing
- Stow equipment

# 06 EXPERIMENT CONDUCT

This function is the responsibility of the MM crew, except in those cases where experiment conduct is controlled automatically or remotely from ground or Space Station (see Function D).

The nature of the function to the crew will vary widely, from simple monitoring requirements (where actual performance is almost completely automatic), to step-by-step participation by both crew and instruments, to those experiments where crew members are both experimenters and subjects. Crew skills must reflect the nature of the equipment being utilized, the subject of the experimentation, and the type of data being collected.

Major subfunctions are:

- Control experiment equipment
- Observe object/subject of experiment



- Monitor experiment progress
- Evaluate experiment results

# 07 DETACH EXPERIMENT MODULE (EM)

This function will be the responsibility of the EM crew, the flight crew, or both. Only two types of missions requiring this function are foreseen:
(1) after initial setup of a long-duration, automated, free-flying RAM<sup>T</sup>;
(2) after completion of periodic servicing in orbit of the automated, free-flying RAM. A third type of mission is also possible, e.g., when, because of a malfunction, the EM cannot be properly stowed in the Orbiter for return to earth. In such a case, the EM crew (if occupying the EM) would return to the Orbiter, and the EM would be left in orbit.

The function will consist primarily of assuring that all appropriate spacecraft and RAM systems are secure and operating as intended, and then performing undocking. Actual undocking will probably be mechanical unlatching of the retaining mechanisms, followed either by passive separation (drifting apart) of the Orbiter and RAM, or active separation wherein either the RAM or Orbiter uses propulsive power to achieve separation.

Major subfunctions are:

- Secure Orbiter-RAM interfaces
- a Initiate undocking

All remaining subfunctions are expected to be totally flight-crew functions, although the EM crew (if present) may provide some general support. It is possible that EM crew members may remotely "fly" the RAM away from the Orbiter, if the RAM has an active propulsion/separation system.

See also 08 (RETRIEVE EM)

# 08 RETRIEVE EXPERIMENT MODULE (EM)

This function will, in all likelihood, be primarily the responsibility of the flight crew, although the EM crew may provide some support and, in the case of a self-propelled, free-flying RAM, may actually fly the RAM to the Orbiter by means of remote control, in order to initiate docking.

Major subfunctions are as in 07 (DETACH EM), but in reverse. Constraints and conditions are the same.

# 09 PERFORM SCHEDULED MAINTENANCE

This function will be the responsibility of the EM crew or the flight crew, depending on the specific mission being serviced. This function may

<sup>&</sup>lt;sup>†</sup>Research and Applications Module



occur as part of periodic servicing of an automated, free flyer, or it may be part of the schedule of events to be performed during a manned R&A mission.

The functions will include items such as cleaning, lubricating, realignment, recalibration, testing, and inspection of experiment equipment, as well as scheduled replacement of equipment components and modules. In most cases, the functions will be performed in a shirtsleeve environment, although it is possible that some elements may require IVA or EVA.

Crew skills required are envisioned as being primarily technical, rather than scientific, and in many cases no special skills will be required.

# 10 PERFORM UNSCHEDULED MAINTENANCE

This function is very similar to 09, with the additional functional requirements of trouble-shooting, malfunction analysis, and equipment repair. Unscheduled maintenance may be required at any time, as indicated by the identification of a malfunction, fault, or abnormal operation of equipment. Functional performance may be by either the EM crew or the flight crew, or by both, depending on the problem and the type of mission.

The environment for performance of this function may be shirtsleeve, IVA or EVA. Crew Skill requirements should be similar to those in Function 09.



# APPENDIX B

## CREW FUNCTIONS\*

- O1. STATUS MONITORING Maintain cognizance of progress of events and operations by reviewing status indicators. Indicators may be visual, aural, etc. MONITORING requires use of intervening equipment between subject (object), system and monitor. It is either automatic or semiautomatic, never manual. This function is system or equipment oriented, and displays require little or no interpretation, being primarily go/ no go, or "within pre-established limits", or direct readouts of quantitative data, e.g., pressure, temperature, elapsed time, etc.
- O2. OBSERVATION Attentiveness to status, or changes in status, of the object or subject of experimentation. OBSERVATION may be indirect through the use of supporting equipment and instruments. This function is experiment oriented, and the observed parameters may be either quantitative or qualitative in nature. Interpretation of the observed parameters will generally be required in light of the nature of the experiment and the object or subject being observed.
- 03. INSPECTION Performance of critical visual examination of operating equipment units for a specific condition, in order to determine whether the equipment should continue in operation or use, or whether repair or replacement is required. Also included will be the examination of parts and materials for evidence of wear, deterioration, or defects. This function is equipment and facility oriented and is primarily related to maintenance activities.
- 04. PATTERN RECOGNITION Classification of phenomena or events based on current data. The classification rules will be either deterministic or probabilistic but will be unknown prior to recognition. This function is experiment oriented, and the OBSERVATION function is generally a prerequisite. The function may be thought of as the integration of observations, ambient conditions, and other factors to form a relevant conclusion.
- 05. COMMUNICATION Transmittal of pertinent information regarding any aspect of the experiment or equipment to other locations. COMMUNICATION may be direct (through voice, touch, or signal) or may be indirect through the use of electronic equipment.
- 06. DATA PROCESSING Accepting data, information or experiment related material in one form, and, through mental, manual, or machine manipulations, transforming it into another form. This function is common to all aspects of Experiment Module operation and maintenance, although emphasis will be given to areas related to experiments. Examples may be tasks such as film developing, transforming CRT-displayed data to hard-copy, making straight forward arithmetic calculations, and entering data into the computer to be run against a pre-established program.

<sup>\*</sup> Utilization of Crew Functions is explained in the text, paragraph 2.2.3.



- 07. FAULT ISOLATION Determination of the type, cause and location of a failure or malfunction which has occurred in experiment equipment or in experiment support equipment. In many instances, the location of the failed item may be provided by the status monitoring instrumentation or by Built-In Test Equipment (BITE). In other cases, some level of equipment disassembly may be required to locate the malfunctioning part to the lowest replaceable module.
- 08./09. CALIBRATION/ALIGNMENT CALIBRATION is the determination of accuracy, deviation from norm, or variation, by special measurement or by comparison with a standard. ALIGNMENT is the adjustment of controls (in some cases direct movement of equipment units) so as to match visual indicators such as pointers, wave forms, and lines of sight, or to alter aural signals until coincidence is achieved. These two functions are very similar, and are therefore grouped together. In CALIBRATION, the objective is to determine the amount of difference; in ALIGNMENT, the objective is to eliminate the difference even though the amount of the difference may be unknown. In some cases, the function will be largely automatic, so the crewman's task is primarily one of initiating the sequence when it is needed and monitoring its progress. In other cases, the function may be completely automatic and will require no crew attention at all.
- 10. CONTROL Active provision of inputs to a system, equipment, or operation, to insure that it remains within the limits selected by the controller and/or follows a definite sequence of operations determined by the controller. CONTROL may be continuous, sequential, or even intermittent, and it requires that inputs be made to the system or equipment while it is operating or to the operation while it is in progress. The primary information on which CONTROL is based is feedback from the system, equipment, or operation to the controller, and the relationship of that feedback information to what is desired by the controller.
- 11./12. EVALUATION/ANALYSIS Careful examination and interpretation of test or experiment results, or of the characteristics of the subject/object of a test or experiment, to determine the conditions represented by those results and/or characteristics. EVALUATION generally involves a purely mental process wherein the results of characteristics are weighed against the evaluator's prior knowledge of what is expected. ANALYSIS generally goes a step further and may require that data be transformed, calculations be made, or results or characteristics be quantitatively and/or qualitatively matched against some pre-established standard.
- 13. DECISION MAKING Selection of a course of action based on a probabilistic estimate on which of several courses is most likely to result in success. A simple "decision" to proceed as planned involves DECISION MAKING only if new information has created some reasonable alternative courses of action. One or more other functions, such as STATUS MONITORING, OBSERVATION, PATTERN RECOGNITION, and EVALUATION/ANALYSIS, will almost always precede this function.

- 14. TEST AND CHECKOUT Performance of operational readiness testing on components, equipment, and systems to determine that they are operating, or will operate, within acceptable limits. This function will almost always include the use of some specialized instrumentation to enable the crewman to more readily ascertain the state of readiness of the equipment. The process may, in fact, be almost totally automated, requiring only that the TEST AND CHECKOUT sequence be initiated by the crewman. This function is very similar to FAULT ISOLATION except that no failure is known to have occurred when it is initiated. The same testing equipment/instrumentation will generally be used for both functions.
- 15./16. ACTUATION/DEACTUATION Initiating/stopping a process or operation by the fairly basic means of turning power on/off, pushing start/stop buttons, etc. Only when the process is time-critical does the function become other than routine. In many cases, it will be preceded by functions such as PATTERN RECOGNITION, DECISION MAKING, etc. In other cases, it will be accomplished in accordance with a pre-established program of events. This function is basically a motor task.
- 17./18. STOW/UNSTOW STOW is the process of packaging an item of equipment, test sample, etc., placing it in a previously designated storage location, and securing it against normal, expected outside influences, as well as preventing the item from interfering with other activities. UNSTOW is, of course, the opposite of STOW. The UNSTOW function will generally occur during experiment setup; the STOW function will generally occur following experiment conduct, during experiment shutdown. The function may be interrupted by other functions such as ASSEMBLY/DISASSEMBLY, TRANSLOCATION, and INSPECTION.
- 19. CLEAN/DECONTAMINATE Removal of dirt, grime, dust, or other contaminants (including biological). This is a very broad function which may range from simply wiping off an object (e.g., optics) with a soft, clean cloth, to subjecting experiment equipment to an ultrasonic "bath". The function may follow the INSPECTION function which determines that cleaning is necessary or it may be a preprogrammed event, and it may or may not be followed by INSPECTION. The complexity of the function will vary with the nature of the item being cleaned, the contaminant being removed, the method of cleaning, and the conditions under which it is being performed (e.g., EVA).
- 20./21. ASSEMBLY/DISASSEMBLY ASSEMBLY is the performance of the various manual operations of fitting and securing together two or more equipment items in order to complete a subunitary or unitary assembly. DISASSEMBLY is the reverse of ASSEMBLY. The function may be performed as a maintenance activity (during repair, replacement, cleaning, etc.) or as an experiment-oriented activity (during experiment set up or shutdown). The function is primarily motor, but will in many cases require detailed knowledge of the equipment to be assembled or disassembled.
- 22. TRANSLOCATION Movement of a mass (e.g., cargo, film magazine, equipment unit, or test sample) from one point to another point. Complexity is determined by factors such as origin, destination, available routes, size, mass and translocation assistance. The function may be semiautomatic or manual, and it may be



within a given environment or between different types of environments. When the function is manual, it may or may not include crewman LOCOMOTION.

- 23./24. DEPLOYMENT/RETRIEVAL DEPLOYMENT is positioning an item of experiment equipment in its operational location and configuration and securing it in that position and configuration. RETRIEVAL is the reverse process. If movement of the item of equipment from point to point is required, TRANSLOCATION is a necessary, integral function. DEPLOYMENT/RETRIEVAL may be manual, semiautomatic or automatic.
- 25. LOCOMOTION Movement of the body from one point to another point at some finite distance from the first. LOCOMOTION may be completed unaided (e.g., walking, floating, jumping, "swimming") or partially aided (e.g., self-propulsion devices, carriers, moving treadways, etc.). LOCOMOTION refers to the movement of the crewman; it does not refer to an item of equipment, a test specimen, or cargo. LOCOMOTION may be involved in TRANSLOCATION of such an item, however.
- 26./27. REMOVAL/REPLACEMENT REMOVAL is the performance of the various manual operations necessary to take an equipment item, test specimen, or module out of the next larger assembly or system. REPLACEMENT is the opposite of REMOVAL, and further includes initial "placement" or installation of the item in the larger assembly. A distinction must be made between REMOVAL/REPLACEMENT and ASSEMBLY/DISASSEMBLY. In REMOVAL/REPLACEMENT, the major assembly remains basically intact, although it may or may not be operable with the equipment unit removed. In ASSEMBLY/DISASSEMBLY, the major assembly or system does not remain intact, and, when disassembled, it is always inoperable.
- 28. REPAIR The act of restoring damaged, worn-out, or malfunctioning equipment to a serviceable, usable, or operable condition. REPAIR may include both ASSEMBLY/DISASSEMBLY and REMOVAL/REPLACEMENT functions, and it will usually require the use of special tools, equipment and materials for successful accomplishment of the function. The FAULT ISOLATION function will be a frequent prerequisite.
- 29. UNKNOWN The nature of the crew functions cannot be determined due to insufficient information and/or detail.
- 30. SUBJECT FOR EXPERIMENT A function in which one or more crewmen are evaluated as to their performance, response to stimuli, physiological state, etc. They represent "test specimens", experiment variables, etc., and, in such capacity, they may be called upon to perform any of the other crew functions which have been identified. In this analysis, crew functions performed as a SUBJECT FOR EXPERIMENT will always be shown in addition to the crew functions performed as experimenters, experiment controllers, etc.
- 31. OCCUPY This is a specialized crew function wherein the crewman must be located in or on a particular item of equipment or a specific location with respect to the equipment. OCCUPY includes sit, stand, lie, etc. It is a passive function in that no particular activity is expected.



- 32. WEAR This is a specialized crew function, similar to number 31, where the crewman is clothed in a particular kind of garment, or is bearing certain items of equipment that are strapped or otherwise fastened to his body (e.g., helmets, harnesses, etc.). Other crew functions are generally performed at the same time.
- 33. RECEIVE A specialized crew function, wherein the crewman is the recipient of some experiment-related substance or material. As used in this study, the function includes ingestion of foodstuff or medication, receiving hypodermic injections, etc.
- 34. DONATE A specialized crew function, the reverse of RECEIVE. The crewman gives up material for the purpose of the experiment. Such activities include the taking of blood, urine and fecal material sampling, and provision of saliva for tests.

# WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

CONTRACT NAS8-28359

FINAL REPORT

APPENDIX C

TASK-SKILL/OCCUPATIONAL SKILL
CROSS-REFERENCE BY PAYLOAD



#### APPENDIX C

# TASK-SKILL AND OCCUPATIONAL SKILL CROSS-REFERENCE BY PAYLOAD

This appendix comprises a series of Tables showing the assigned task-skills, Primary Occupational Skills, and Mission Occupational Skills for each payload studied, individually. It is intended primarily for users of the information who are working at the payload level, and who are not concerned with combined payloads or mixed payloads.

The tables included, and the relationship to the composite tables in Section 3.0 of the text, are as follows:

			REFE	RENCE TABLE #	
P/L #	EXP. #	TITLE	INDIVIDUAL PAYLOAD	PAYLOADS IN DISCIPLINE	ALL EO & MS
. EO-3		Air and Water Pollution	C-1		
EO-4		Resource Recognition	C-2	3-2	
EO-5		Disaster Assessment	C-3		
MS-1	(1)	Biological Experiments Separation of Biologicals	C-4		3–6
MS-2	(1) (2) (3)	Levitation Experiments Preparation of Glasses Supercooling/ Homogeneous Nuc. Crystal Growth from Solutions	C-5	3-4	
MS-3	(1) (2)	Furnace Experiments Composite Materials Liquid Dispersions	C-6		
MS-4	(1) (2)	Small/Low Temperature Experiments Fluid Convection Crystal Growth from Solutions	C-7		



TABLE C-1: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-3 (Air and Water Pollution).

	TASK - SKILL	PAYLOADS/EXPERIMENTS	ir & Water Pollution							OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Systems Engineer EDB	Instrumentation Technician	Optical Technician		$\vdash$	+	Calibrator	Camera Inspector	Electronics Mechanic	Special Spaceflight Skill					
		₹	EO-3 A						1	CODE	000.000	003.181	787 187	003.281	007.081	024.081	025.088	288	710.884	722 281	828.281	xxx.xxx		Î			
CODE	TITLE				1	$\perp$	Ц	1	1,		00	00	3 8	8	8	027	072	6		= = =	828	8		$\perp$	$\perp$		
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	Spectrometer Control Actuator Spectrometer Fault Identifier	1	H	++					-	<b>}</b>	+	4	+	140	-			-	+	+	1	$\left  \cdot \right $	-		+	1	3
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	Film Cartridge Installer				2	3 8		<u> </u>	].	्री	1			B						I	I			I	I		
0072	Spectrometer Calibrator Spectrometer Optics Cleaner	I		+-{	+	+-	H	+	$\dashv$	-	4	4	+-	-K	-	-	$\dashv$		4	+	₩	$\sqcup$	+	+	+	+-4	<u> </u>
0095	TV Camera Optics Cleaner	1	云	<del>]  </del>	+	+	$\vdash \vdash$	+	+	+	+	+	+	檢	-		+	+	+	+	+	$\vdash$	+	+	+-	+	_
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0109	Spectrometer Module Remover	<b> </b>	Ķ	1	+	<del> </del> -	$\mid - \mid$		4	-	-49	<u>)</u>	1	X	_		_		- -	_	↓_	]_	Ţ	Ţ	Ţ	П	
0110	Spectrometer Module Installer TV Camera Module Remover.	1	长	-	+-	+-	$\vdash$	+	$\dashv$	ŀ	+	섻-	+	⊹	-	-	-		+	+	+-	-	-	-	+-	H	
0112	TV Camera Module Installer	Ì	Z	; †	1-	1		+	7	1	7	1	†	兌		-		$\dagger$	十	十	+		+	+	+	1-1	
0158	Camera Module Remover				$\perp$							1		X	O				I	I	I			I	1		
0160	Camera Module Installer		长	1	- -	-	$\vdash$	+	-	-		4	+	₩	2	_	-	+	+	+	+-	$\vdash$	4	4			
0187 0188	Telescope Module Remover Telescope Module Installer		长	1	+-	+-	$\vdash$	$\dashv$	7	+	+	+	+	兌	K	-				+	+	$\vdash$	+	+	+	Н	_
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0206	Radio Communicator			$\Box$	I	L		1	7		1	1	1	X			$\Box$		T	I	T		1	T	I	П	_
0209	Scanner Mode Monitor TV Camera Mode Monitor		层	++		-	Н	-		-	+	+	+	X	H	-	$\dashv$	-	+	+	+-	$\vdash$		-	+	$\vdash$	
0212			人	1	十	+	-	+	4	ŀ	+	+	+-	常			-	+	+-	+	1		+	+	1-	$\vdash$	
0265	Telescope Mode Selector A. Market Harris Branch Branch		区		工			士			K	I	I	N.		X			1	土			1	土	土	口	
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0268	TV Mode Selector  Camera Mode Selector				+-	+-	-		-	-		╣-	+	8	H	쉿	ᆉ	+	+-	+-	╂╌	H	+	+	+-	╁╌┤	<u></u>
0271	Camera Inspector	}}			+	1	-		7	-	1	1	+	183			7	+	1	寸	X	$\vdash$	-	+	+	+	
0297	Telescope Aligner													8				Ţ		I	X		1	工	上	$\Box$	_
0320	Telescope Control Deactuator	)]		1	4	Ļ.,	Ц	_ _	4	-		4	1	13	$\sqcup$		4	4	$\downarrow$	↓	1	Ц	4	$\bot$	4	$\sqcup$	
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0644	Radiometer Mode Monitor		$\square$		+-	Н	1	十	1	r	┲	4	+	核		+		-	+	†		7	-	+	+	$\Box$	
0653	Polarimeter Mode Monitor	11			I			1	] .		I	I	I	S				I	I	I	$\Box$	1		I		П	
0672	TV Camera Control Deactuator		A		+	$\dashv$	_	4	↲.	+	4	+	+	8	$\sqcup$				+	+	+-1	-	4	4	4	┯	
	Radiometer Control Deactuator TV Camera Fault Identifier	sès	K		+-	╁┤	$\dashv$	+	-	٠ }-	╁	+	F	X	H	$\dashv$	+	+	十	+	卜	+	+	╫	+	┢╍┼	
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<sup>\*</sup>No Occupational Skill Assigned; see text, paragraph 3.2.1
\*\*No Mission Occupational Skill Assigned; see text and Figure 3-2



TABLE C-1: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-3
(Air and Water Pollution).
(Continued)

	TASK - SKILL	PAYLOADS / EXPER! MENTS	Air & Water Pollution						E OCCUPATIONAL SKILLS	Н	+	+	1 Instrumentation Technician	$\Box$	+	ナ	$\dashv$	4 Calibrator	╫	Electronics	$\vdash$			
CODE	TITLE	$\  \ $	E0-3						CODE	000.000	003.181	003.187	003.281	007.081	024.081	025.088	025.288	714 684	722.281	828.281	XXX XXX			
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0844	Polarimeter Control Actuator	1	$\Box$					1	1/2				$\langle \rangle$			1	1	Î	12					
0846	Telescope Control Actuator Camera Control Deactuator		$\Diamond$		1		1	ļ.,			<u>.</u>		X			1		L	1		8	$\perp$	П	
0848	Scanner Control Deactuator		云			7		1			-	+				+		+	+	-	+	-	++	
0852	Film Stower	1	Ď	$\Box$	$oxed{\Box}$	П	1	E	]		7	T	X	$\Box$	7	1	1	I	$\Gamma$			I	П	$\Box$
0869 0870	Scanner Data Quality Monitor Radiometer Data Quality Monitor	1	K	+	+	H	+	+-	ł	$\vdash$	+	+	X	$\dashv$	+	+	+	+-	+	Н		+	+	
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0873	Polarimeter Data Quality Monitor Telescope Operation Evaluator	<b>∦</b> ~.	$\mathbb{R}$		+	H	-	-			4	-	X	$\dashv$	4	4	1	+	1	H	1	$\bot$	$\prod$	$\Box$
0874	Telescope Operation Evaluator  Camera Operation Evaluator	1	A		+-	╁┼	+	+		$\vdash$	十	+	뷩	+	$\dashv$	+	+	+-	╫	Н	+	+-	H	
0876	Scanner Operation Evaluator											I	8		1									
	Radiometer Operation Evaluator				ـ	-	_	-			-	-	12	4		1	-		ļ				$\sqcup$	
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0884	Scanner Optics Cleaner									$\Box$	$\Box$	I	Z						$\Box$			$\perp$	П	$\Box$
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0887	Scanner Fault Identifier	11	区	+	-		+-	$\vdash$		7	+	+	$\cap$	4	+	+	+	+	╁╌	3	+	+	f + f	$\dashv$
0889	Polarimeter Fault Identifier	1		$\top$							1				1	1				Š	1	工	口	
0891 0895	Optical Equipment Fault Identifier Telescope Presentation Observer		爿		-		+	$\vdash$		-	+	+	X	4,	↲	+	+	┼-	-	-	+	+-	$\vdash$	$\dashv$
0896	TV Presentation Observer										1	士		}		$\perp$					1	1		
0897	Scanner Presentation Observer	<b> </b>	(A			_	1			4	7	1		_	\$	_	$\bot$	L			$\bot$	T	П	$\Box$
0898 0904	Radiometer Presentation Observer Scanner Module Remover		岗		$\vdash$	+	┿	╁┤			╗	+	k	-	겍.	+	+	╁	H	$\vdash$	+	+-	╁┼	
0905	Scanner Module Installer	11				士		口			Ó		X		1	1					1		口	口
0908	Polarimeter Module Remover		$\mathbb{Q}$			_		П			<u></u>	L	X	7	$\perp$	1	1	L		П	_	1	Ш	$\perp$
0909	Polarimeter Module Installer Polarimeter Presentation Observer	10		+	H	-	+	╁╌┨		-	+		H	-12	줘-	╂	+	┼	Н	Н		-	H	-
0915	Spectrometer Presentation Observer		口								1				X X	1					1	上		
0916	Scanner Mode Selector			$\dashv$		$\perp$		$\vdash$		{	잌_	+	$\bigotimes$	- 13	3	4	4	╀-	-			+-		
0917	Radiometer Mode Selector Polarimeter Mode Selector		8	+			╁	H	}	- 1	4	+-	쉱	-	솱	+		┼		-	+		- -	
0919	Polarimeter Control Deactuator		N			$\perp$				コ			Ø	Í							工		П	口
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0925	Polarimeter Optics Cleaner	1	〇	工		士	上			$\exists$		1	0		1		1					$\pm$	口	口
0926	Earth Survey C/D Equipment Module Remover		읝	-		-		$\sqcup$		-{	4	4			+	+	-	┼		X		+-	╁	┦┩
0927	Earth Survey C/D Equipment Module Installer Earth Survey C/D Equipment Fault Identifier		Ħ	+	-	+	+-	┤┤	ł	-	+	+	M	+	-	+	+	+-		忿	+	+	十	+-1
0942	Telescope Mode Monitor					1	I	口	l	1		I	D	1	1	1	1	L			1.		口	口
0943	Telescope Mode Recorder	.::.	伿		$\vdash$	+		$\dashv$		-+	4	+	Ö	#	+	-	+	-		됬	- -	╁┦	╟	- -
	Telescope Repairer TV System Repairer		团	+	H	+	+	H	ŀ	十	+	+-	敓	St	+	$\dagger$	+	$\vdash$	$\vdash \mid$	贫	+	$\dagger$	-	+
1195	Camera Repairer		Ø	$\perp$	口	#	$\bot$	口	ļ	#	I	I	図		1	1	T	$\Box$		ত্র	1	$\Box$	口	耳
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0= P	rimary Occupational Skill. $[\overline{\mathtt{X}}]$ = Mission Occupational Sk	cill.	ĺ	<u> 7</u> =	Tas	sk-	Skil	ΙR	equ	ire	d l	рγ	ау	oad	d/E	×ι	oer	ime	nt.					



TABLE C-1: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-3 Correlation of Task-Skins (Air and Water Pollution) .

(Continued)

2050 2051 2053	TITLE Spectrometer Mode Récorder Camera Status Monitor	Ya	A Air & Water Pollution							OCCUPATIONAL	General Technical Skill	Electrica	Radio Engineer	Systems	Instrumentation Technician	Optical Technician	Geophysi	Meteorologist	Weather U	Calibrator	Inspector Systems	Electronics Mechanic	Special Spaceflight Skill				
2049 2050 2051 2053	Spectrometer Mode Recorder Camera Status Monitor	_	- 14							CODE	000.000	003.181	003, 187	3.187	003.281	007.081	024.081	025.088	025.288	717, 594	727 281	828.281	xxx.xxx				
2050 2051 2053	Camera Status Monitor	22	FO-3	2				$\perp$	L	Ľ	ĕ	g	8	8	8	00	20	2	3 :	3;	15	828	L\X				
2051	Camera Status Monitor	1	$\mathbb{Z}$	2		8		9 3								-				77	1			7	1	1	ि
2053			<u> </u>	$\Delta \Gamma$					L						SI.	$\supset$	I	I	ÿŢ.	I	I			$\Box$		I	I
2053 2054	Time Elapsed Observer.**	7	\/	4	4	[2]	4	4	_		_				-	-4			4	_				4.	4	1	1
<u>zu541</u>	Atmospheric Pollution Data Observer	<b>;</b> ;;	17	4	40	$\vdash$		18	-	12	-	-	_		_	19		40	1	4	4		-	4	4	4	4
	Water Pollution Data Observer Water Pollution Data Evaluator	1		4	+		+	-	╁	P\$\$.	1	1-			4		<u>X</u>	+	+	+	╁	+	┝╌┤	+		+	+
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	Meteorological Conditions Evaluator	11	×	7	+	-	$\dashv$		$\dagger$	1	-		-	+	+		3			十	+	1-	-	+	+	+	+
	Mission Events Evaluator**			7	$\top$		+	_†-		1		Г		7	$\top$	Ť	1	7	1	$\uparrow \neg$	+		ot	+	+	$\dagger$	+
2059	TV System Inspector	]]		7			I		$\mathbb{L}$	1						$\Box$	1	I	I	I	10	X		$\Box$		1	I
	TV System Tester			7			$\perp$			]		$\Omega$			XI.	$\perp$			$\perp$	I	L			$\perp$	$\perp$	I	I
2061	Scanner Tester		4	7	_		4	4	1_			Ç	$\sqcup$	إ	4	4	_	4	4	4	1_	-	1_1	4	4	1	1
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	Polarimeter Aligner TV System Fault Identifier	1	1	<del>} </del> -		$\vdash$	-		+-	}	-	$\bigcirc$	-		X V	ᆛ	+	-}-		4-	+-	<del> </del>					
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2080	Spectrometer Data Classifier Polarimeter Controller **	il	- X	₹}-		-+			┼					-	+		斗-	-	+	+	+-	H	$\forall$		+	+:	+
	TV Data Analyzer	1	1	╬	+-	-	+	+	+	٠.		H	-	-+	+	+	<del>a</del> -	+	+	+	+-	+-+	4	+	+	+	+-
	Scanner Data Analyzer	11	7	₹	$\vdash$		-	十	1-		Н		-	-	+	15	X X	十	╅	+	†	$\vdash$	+	╅	+	+	┿
	Radiometer Data Analyzer	11	$\overline{}$	1	+	H	十	+	$\top$		Н		_	十	+		3	十	+	+-	1	H	_	$\dashv$	十	+	+-
	Polarimeter Data Analyzer	11	Z	7	1	H	+	1	1	ĺ	П		7	一	1		XI.	1	十	1	1		$\exists$	1	+	T	$\top$
2086	Spectrometer Data Analyzer			7			. T	Ι		İ						7	20	I	m I	I				Π.	I	I	T
2087	Telescope Data Analyzer	1		<u>.</u> V				L						1		_[2		I	1	L	L		$\Box$		I	I	I
2088	Scanner Adequacy Determiner		K	4	↓_	4	4	_	-		Ш			- 2	<u></u>	1	<u></u>	4	4	+	4	$\vdash$		4		4	
2089	TV Camera Adequacy Determiner		*	4-	1_	$\dashv$		_	-		$\vdash$	<u> </u>		-\$	糾	-12	<u> </u>	4-	+	+-	╀		4	4		+	+
2090	Radiometer Adequacy Determiner			4-	+-	-	+	+	-	3	┝╌┤	-		-14	욹.	-16	ŤČ	∜-	+-	+-	-	╂╌╂		+	+	+-	+-
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2096	Radiometer Operation Monitor			7	$\square$		Ι.							Ž	4	I	I	I	I	I		$\Box$	$\supset$	I	I	I	I
2097	Polarimeter Operation Monitor		14	4	1_		1.	4			Li	_	4	_{	<u> </u>	1	4	1	4	<del> </del>	1_!	1-1	4	4	4	4	4-
3098	Spectrometer Operation Monitor	"	1	4-	1		4	+	-	-	H		4		*	4	+	+	+-	-	+			+	+	+	+
2099	Telescope Operation Monitor			4	1-	-	+		<del> </del>		$\vdash$		-+		4	12	<del>:</del>  -	+	+	+	-	<del>  -  </del>	-+	+	+	+	+
2101	Atmospheric Pollution Data Classifier Water Pollution Data Classifier	1	· (7)	4	+-		+	+-	+-		┢┪	-	+	+	+	-16	하	+	+	+-	1-	<del>                                     </del>		+	+	+	+
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TABLE C-2: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-4 (Resource Recognition).

	TASK - SKILL	PAYLOADS/EXPERIMENTS	Resources Recognition						OCCUPATIONAL	+	┰	Justinimentation Technician	+-	1		8 Weather Observer		d Camera Inspector	┿	├				
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	Spectrometer Control Actuator Spectrometer Fault Identifier	41	$\bowtie$			<u>ं ।</u> या ।		14		4	<u> </u>	12	4		70		4	* 1	1					
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	Film Cartridge Installer	1			N		1-1		ी	Ť	-	0	<u>s</u>		93	7	ी	Ħ.				1		2 1
0072	Spectrometer Calibrator	]		$\perp$		$\Box$	П	口				$\sum$				$\Box$			T					$\Box$
0095	Spectrometer Optics Cleaner	}]	띩	4	$\sqcup$	- -	+	Н		4	4	2		Н	Ш	4	4	$\bot$	_	$\vdash$	dash	1	$\perp$	1
0097	Camera Lens (Optics) Cleaner Spectrometer Module Remover	{	H		$\vdash$		+	Н	ŀ	1	=	18	<del>}-</del>	Н	_	+	-+		┼	$\vdash$	+	+	Н	+
0110	Spectrometer Module Installer		H	+		+	Н	Н	t	Ŕ	51	K	<del>}</del>		$\dashv$	$\dashv$	$\dagger$	+	+	$\vdash$	1	+	$\dagger \exists$	+-
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0160	Camera Module Installer		糾	4		1	-	$\sqcup$	- }			X	10		_	-	4	_ _	<del> </del>				$\sqcup$	
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0209	Scanner Mode Monitor		M			$\perp$						12										I		
0245	Camera Control Actuator			4	$\sqcup$	$\perp$	$\perp$	Ц		_	$\perp$	ĮQ.	1		_	_	1	_	1		4	$\perp$	$\sqcup$	
0265	Telescope Mode Selector Spectrometer Mode Selector				╌┼	- -	+	Н	-	-{	4	X	<del> </del>  -	0	4	4	+		+-		+	+-	+	+
0267	Camera Mode Selector		H	+	$\vdash$	+	+	Н	ł	-1	<del>ŏ</del> l-	1	+	3	ᆟ	+	╅		+-	Н	+	+-	+	+
0294	Camera Inspector								1			Í							X					
0297	Telescope Aligner										1	. 2				_(	2		$\bowtie$		1		Ш	
0320	Telescope Control Deactuator Film Processor*		윉	+-		+	+	H	ŀ	+	+	12	-	$\dashv$	-	+	+	+		-			╁┈┧	
0328	Spectrometer Control Deactuator		計				┿┥	-		-+	+	100		-		+	+		-	$\vdash$		+	+	+
0516	Meteorological Condition Observer										土	Ï		X	$\bigcirc$	<u> </u>	1							工
0519	Computer Module Remover			$\perp$		$\perp$	П			_(	$\supseteq$					$\perp$	I				$\perp$	Ţ	П	$\perp$
0520	Computer Module Installer		$\mathbb{A}$	$\bot$	$\vdash$	+	<del> </del>		-	-{	$\Im C$	奖		-	-	4	+	+	-	$\sqcup$		-	$\sqcup$	
0613	Radar Transmitter Tester Radar Transmitter Module Remover	II			-	+-	H	$\dashv$	-	+	北	⊀	+	$\dashv$	+	+	╁	+	-	$\vdash$	+	+	++	+-
0616	Radar Transmitter Module Installer		团	-	-		+	-	:- }	-1	5	长	+	$\dashv$	+	+	+				+	+	1-1	1
0623	Radar Receiver Module Installer		M									X					1					1		
0624	Radar Receiver Module Remover		口	1.					-	4	2	X	1.1	_	4	_	1	4	ļ.,		4	4.	$\sqcup$	
0627	Rader Receiver Tester Radiometer Module Installer		$\mathbb{H}$	+-	-	+	H				⇟	₩	+	-	-	-	- -		-			-	++	
0637		3	$\Theta$	+-	-	+	+		4	₹	٦Ť	忟	+-1	-	+	+	+	+			+	+	11	
0641	Radiometer Tester	ľ									工	$\Sigma$				$\perp$	1	1				L	П	
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0653	Polarimeter Mode Monitor		₩.	+-	+	+-	$\vdash$	$\dashv$	ŀ			X	-	-	+	+	+	+	Н		+	╀	$\vdash$	
0664	Radar Transmitter Control Deactuator Radar Receiver Control Deactuator		X	+	1	+	╁	-	·ŀ	+	<del>-</del>	檢	-	-	:+	+	+	- -	Н	-	+	+-	H	-
0673	Radiometer Control Deactuator		ZT.			1	H	7	1	3		Š			7			1				L		
0683	Radar Transmitter Fault Identifier		[4]	$\perp$			П		[	1	$\perp$	L	$\Box$	_	$\perp$	$\perp$	1	1		1	- -	ļ	_[	
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	Spectrometer Mode Monitor		$\mathbb{A}$	-	+	┽┈	┯	+		+	+	Ø	H	+	+	+	+	+	8	+	+-	+	$\vdash \vdash$	+
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กลาวไ	Spectrometer Inspector	il i	V. VI	1 1		1	<b>L_1</b>		1	L	1_	1	1	1	- 1	1	1	-1-	$\triangle$	_1		ــــــــــــــــــــــــــــــــــــــ	1_1	لسلسا



TABLE C-2: Correlation of Task-Skills with Occupational Skills, Sortle Lab Payload E0-4 (Resource Recognition),

(Continued)

TASK - SKILL   TASK		· · · · · · · · · · · · · · · · · · ·				T		T	T	1.5			<u>.</u>	Ctan					$\overline{}$	T			T		
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CODE		TASK - SKILL	/EXPER	Recog		-				UPATIC	al Tech	ical Te	ns Eng	mentat	vsicist	rologis	er Obse	ator	dsul e.	tor	Space	200			
CODE   TITLE			OADS	ources						ŏ	Gener	Electr	Syster	Instru	Geoph	Meteor	Weath	Calibr	Camer	Spec	Sperit	22.2			
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0840   Scanner Control Deactuator	0846	Telescope Control Actuator		A		1		T.					T(						1						
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1995   Scanner Module Installer   1998   Polarimeter Module Remover   1999   Polarimeter Module Installer   1991   Polarimeter Presentation Observer   1991   Polarimeter Presentation Observer   1991   Scanner Mode Selector   1991   Scanner Mode Selector   1991   Polarimeter Mode Selector   1991   Polarimeter Mode Selector   1991   Polarimeter Mode Selector   1991   Polarimeter Control Deactuator   1992   Polarimeter Optics Cleaner   1992   Radiometer Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Optics Cleaner   1992   Polarimeter Module Installer   1992   Radar Survey C/D Equipment Module Installer   1993   Radar Receiver Inspector   1993   Radar Receiver Inspector   1993   Radar Receiver Control Actuator   1993   Radar Presentation Observer   1993   Radar Receiver Control Actuator   1993   Radar Receiver Control Actuator   1993   Radar Receiver Mode Selector   1993   Radar Receiver Mode Selector   1993   Radar Receiver Mode Selector   1993   Radar Receiver Mode Selector   1993   Radar Receiver Mode Selector   1993   Radar Receiver Mode Selector   1993   Radar Receiver Mode Recorder   1994   1995   1			l	M	1	1	11	+	$\dagger \lnot$		1	at	15	汁	$\vdash$		+	+	十	+-	+	$\vdash$	+	++	+1
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1917   Racilometer Mode Selector				$\triangle$						2.0		1			Ø										
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19919   Polarimeter Control Deactuator	*****			X		-			╀┤	3.	-	4	- 6	1		-	-	+	+	+	-	$\vdash$	+	╀╾╃	+1
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0928   Earth Survey C/D Equipment Fault Identifier	-				$\Box$	$\Box$		I	П			$\perp$	(2	1	П			$\Box$	$\perp$				$\bot$	П	$\Box$
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0928   Earth Survey C/D Equipment Fault Identifier   0931   Radar Transmitter Inspector   0931   Radar Receiver Inspector   0934   Radar Presentation Observer   0935   Radar Presentation Observer   0936   Radar Presentation Observer   0937   Radar Presentation Observer   0938   Radar Receiver Control Actuator   0938   Radar Receiver Mode Selector   0938   Radar Receiver Mode Selector   0939   Radar Receiver Mode Selector   0941   Telescope Mode Monitor   0943   Telescope Mode Monitor   0943   Telescope Mode Recorder   0944   Camera Operation Monitor   0944   Camera Operation Monitor   0448   Camera Operation Monitor   0448   Camera Tester   0448   Camera Tester   0458   Camera Mode Recorder   0459   Camera Mode Recorder   0459   Camera Status Monitor   0459   Camera Status Monitor   0550   Camera Status Monitor   0550   Camera Status Monitor   0550   Camera Status Monitor   0550   Camera Status Monitor   0550   Camera Status Monitor   0550   Mission Events Evaluator   0550   Mission Events Evaluator   0550   Mission Events Evaluator   0550   Mission Events Evaluator   0550   Camera Tester   0550   Camera Te			11	쉱		-	$\vdash$	╁╌	╁╌┨		1-1	<del>\</del>	К	7-	$\vdash$	$\dashv$	+	+	+	+	-	1	+	╁	+
0933   Radar Receiver Inspector   0934   Radar Presentation Observer   0935   Radar Presentation Observer   0936   Radar Transmitter Centrol Actuator   0936   Radar Receiver Control Actuator   0938   Radar Transmitter Mode Selector   0939   Radar Receiver Mode Selector   0939   Radar Receiver Mode Selector   0942   Telescope Mode Monitor   0943   Telescope Mode Recorder   0943   Telescope Mode Recorder   0944   Telescope Repairer   0945   Telescope Repairer   0945   Telescope Repairer   0946   Camera Repairer   0947   Camera Repairer   0948   Camera Tester   0949   Camera Tester   0949   Secundar Mode Recorder   0949   Spectrometer Mode Recorder   0949   Spectrometer Mode Recorder   0949   Spectrometer Mode Recorder   0949   Spectrometer Mode Recorder   0959   Camera Status Monitor   0959   Mission Events Evaluator   0959   Mission Events Evaluator   0959   Mission Events Evaluator   0959   Camera Teste			777					1		, egy			ŢĹ.	Ì.			$\perp$	1		10					
0934   Radar Presentation Observer				A				Ţ.		Ker		-	Ţ	1			4	4	Ç	$\langle \! \rangle$			-		
0935   Radar Transmitter Centrol Actuator	0833	Radar Receiver Inspector		읝		$\vdash$	-	+-			-		-	+-	82	-	-	4		쑤		-	+	$\vdash$	+
0938   Radar Transmitter Mode Selector				M	+-		3	+	Н		1	1	12				1			1			+	$\Box$	
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1932   Telescope Mode Monitor				以		Н	+	+	$\dashv$	ļ	1	갂	*	<del>}</del> -	阁	4	+	+	-	╁	⊢┤	+	-	++	┼┩
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2047   Radiometer Mode Recorder	1195	Camera Operation Monitor		份	+	-		+	$\left  \cdot \right $	ी	-	+	-12	1	$\vdash$		+	-	+	×	-	+	+	╁┼	+-1
2047   Radiometer Mode Recorder	1448	Camera Tester		X	+	H	+	+	$\vdash \vdash$		1		Ĭ.	1		1	1	+	1	T		$\perp$	1	1	
2049   Spectrometer Mode Recorder	2046	Scanner Mode Recorder	-11 -2000	四				I	口			I	×	1		二	T	T	T	$\Box$		T	T	口	口
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2051   Time Elapsed Observer **			1	团	士			$\perp$	Ħ	į		士	Ź			d	士	士				1	I	口	口
2058   Mission Events Evaluator **	2051	Time Elapsed Observer **		囚	I	$\Box$	I	I		[	I	I	Ţ			$\Box$	Ţ	1	1		미	-	1	$\sqcup \overline{\Box}$	47
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OF Primary Occupational Skill. 🖂 = Mission Occupational Skill. 🔯 = Task-Skill Required by Payload/Experiment.	2062	Polarimeter Tester	L		Ţ		I				K	I	X		Ц	$\Box$	$\perp$	L	$\perp$		П		1	Ш	1
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TABLE C-2: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-4 (Resource Recognition).

(Continued)

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2080 5	Spectrometer Data Classifier						I							士	12	7	上	1	土	土					土		İ
	Scanner Adequacy Determiner		$\stackrel{\wedge}{\triangleright}$			4	4	4	L		_	Ц	П	81	_2	<b>7</b> (	4	4	+	$\perp$	_	$\vdash$	4	+	1	ļ	L
	Padiometer Adequacy Determiner Polarimeter Adequacy Determiner	<b>!</b>	$\mathbb{R}$	-		+	+	+	-			$\vdash$	H	쇬	×	業	1	+	+	+	+	Н	-	+		1	┝
2092	Felescope Adequacy Determiner						1			4	-			ð	Ť	1	1	$\perp$	$\perp$	$\perp$				十	+		<del> -</del>
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TABLE C-3: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-5 (Disaster Assessment).

CODE	TASK - SKILL	A Y LO A DS / EXPERIMENTS	Disaster Assessment							OCCUPATIONAL SKILLS	Electrical Technician	+	4	Surveyor Geodetic	╄-	Geophysicist	╌	4	Camora Inspector	$\sqcup$	Electronics Mechanic	Special Spaceflight Skill			
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1095   TV Centrar Optics Cleaners	0004 Telescope Optics Cleaner								]				XI.												
1996   17 V Camera Optics Cleaner   1997						4.			4	L.			<u>S</u> .	1					1						
10997   Camera Module Remover		-				4			48	-	4	-	X	1	1	20		4	1	-		يُلِ:	44		4
0.158   Camera Module Installer		4100	K	22.0	2 3	1	43		4	-	42	H		4=	-				+	1-1		4	-12-1	H	$\dashv$
160   Camera Madule Installer		11	X	-	+	+	1-1		1	$\vdash$	$\Box$	+		1-	†-	$\vdash$	H	+	1-	†-+	$\dashv$	+	+1		$\dashv$
1887   Telescope Module Remover	·	11	$\overline{\wedge}$	$\vdash$	- -	+	$\vdash$		1	-	tŏ			5	+-	T.	$\Box$	十	†	†*†		$\top$	$\forall$		
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2029   Scanner Mode Monitor					1	1	Ш		1		4		圔_	1	1			_	4_	$\vdash$	_		11		4
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225   Telescope Mode Selector		1	尺		+	+-	+		18	-	┿	-	3	+-		-	-		╁╌	╌┤	-		+-		
Camera Mode Selector		11	$\overline{\Delta}$		1	1		$\neg$	1	-	10	1	ŽŤ	1-	-	Ø	1	+	1	$\Box$	7	-	1		
Camera Inspector	0271 Camera Mode Selector	][			7				1		D		X.		1	$\otimes$	0	1				$\top$	$\square$		$\Box$
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10320   Telescope Control Deactuator	······································	4	$\triangle$	1	┿.	$\perp$	Ш	$\perp$	]	L	1_	11		1	L	Ц	1	_ _	P	1_8	$\boxtimes$	_	$\downarrow \downarrow$	_	4
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3946 TV System Module Remover	0320 Film Processor *	- []			+	+			4	-	-		纤	+-	-		-		┼	$\vdash$	$\dashv$		+	-	$\dashv$
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Radar Transmitter Tester		1	$\triangle$						្រ		Ī		Ĭ			X	$\bigcirc$						$\square$	$\Box$	コ
0615   Radar Transmitter Module Remover   0		]]							]				8)	I			1	$\perp$	_		1	$\perp$		_	
0616   Radar Transmitter Module Installer		41	$\Box$		1	$\perp$			1				4_	1_				$\perp$	L	$\sqcup$	4		44	4	_
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10638   Radiometer Module Remover   10641   Radiometer Tester   10642   Radiometer Unstower   10644   Radiometer Mode Monitor   10644   Radiometer Mode Monitor   10664   Radar Transmitter Control Deactuator   10666   Radar Receiver Control Deactuator   10666   Radar Receiver Control Deactuator   10666   Radar Transmitter Fault Identifier   10683   Radar Transmitter Fault Identifier   10684   Radar Transmitter Repairer   10685   Radar Receiver Repairer   10686   Radar Receiver Repairer   10691   Radiometer Fault Identifier   10692   Radiometer Fault Identifier   10692   Radiometer Repairer   10692   Radiometer Repairer   10693   Radar Transmitter Operation Monitor   10692   Radar Transmitter Operation Monitor   10693   Radar Transmitter Operation				1					10		Ĭ	K	8		П		1	1			7				
10638   Radiometer Module Remover   10641   Radiometer Tester   10642   Radiometer Unstower   10644   Radiometer Mode Monitor   10644   Radiometer Mode Monitor   10664   Radar Transmitter Control Deactuator   10666   Radar Receiver Control Deactuator   10666   Radar Receiver Control Deactuator   10666   Radar Transmitter Fault Identifier   10683   Radar Transmitter Fault Identifier   10684   Radar Transmitter Repairer   10685   Radar Receiver Repairer   10686   Radar Receiver Repairer   10691   Radiometer Fault Identifier   10692   Radiometer Fault Identifier   10692   Radiometer Repairer   10692   Radiometer Repairer   10693   Radar Transmitter Operation Monitor   10692   Radar Transmitter Operation Monitor   10693   Radar Transmitter Operation	0637 Radiometer Module Installer		$\triangle$	$\Box$	I				]		$\bigcirc$		XI.					I				I	$\square$	$\Box$	
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O692 Radiometer Repairer   O795 Electronic Equipment Fault Identifier   O812 Radar Transmitter Operation Monitor   O823 Scanner Unstower   O825 Sferics Detector Unstower   O826 Scanner Inspector   O829 Radiometer Inspector   O829 Radiometer Inspector   O832 Sferics Detector Inspector   O832 Sferics Detector Inspector   O832 Sferics Detector Inspector   O833 Sferics Detector Inspector   O834 Sferics Detector Inspector   O835 Sferics Detector Inspector   O836 Sferics Detector Inspector   O837 Sferics Detector   O837 Sferics Detector Inspector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics Detector   O837 Sferics		41	$\forall$	-	+-	+-1	+	-	∤ઃ	¥	14	-2	4	1		36.	+	4	-		<u></u>	+	++	-	+
0795 Electronic Equipment Fault Identifier   0812 Radar Transmitter Operation Monitor   0823 Scanner Unstower   0825 Sferics Detector Unstower   0828 Scanner Inspector   0829 Radiometer Inspector   0832 Sferics Detector Inspector		11	H	+	+-	╅┪	+	+	1	$\vdash$	$\dagger \dashv$	+	+	$\dagger$	$\vdash$	$\dashv$	$\dashv$	+		ΠÈ	ŠŤ	+	++	+	ヿ
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TABLE C-3: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-5 (Disaster Assessment). (Continued)

	TASK - SKILL	PAYLOADS /EXPERIMENTS	Disaster Assessment						OCCUPATIONAL SKILLS	General Technical	-+	+	Instrumentation Technician	┿	⊢	┝┥	-	Weather Observer	Camera Inspector	╁╌	Electronics Mechanic	Special Spaceflight Skill		
2005		Z	EO-5 D						CODE	000.000	003.181	003, 187	003.281	018.188	024.081	024.081	025,038	025.288	714.684	722,281	828.281	XXX XXX		
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0846	Telescope Control Actuator	110	囚									t)	X						1			1	1	
81130	Camera Control Deactuator										4		1				3					1		
	Scanner Control Deactuator	1			$\vdash$	$\vdash \downarrow$	+			Ц	4	- Ç	<u> </u>	-	-	Н	4	$\downarrow$	4-	₩	$\vdash \downarrow$	_	$\bot$	+
	Film Stower Sferics Detector Control Deactuator	11	出	+	$\vdash$	$\vdash$	+-	-		띰	-+		<u>X</u> -	┼	$\vdash$	$\vdash \vdash$	$\dashv$	+	+-	$\vdash$	$\vdash$	+	+	├┼
	Scanner Data Quality Monitor	{	N	+	$\vdash$	+	+-	+-		Н	-		$\frac{2}{3}$	+		H	+	+	+	<del> </del>	-	+	+-	
0870	Radiometer Data Quality Monitor	]]					1						Ż –				$\Box$	$\exists$						
0882	Sferics Detector Data Quality Monitor								٦. بر										L				$\square$	
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TABLE C-3: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-5 (Disaster Assessment). (Continued)

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•	TASK - SKILL	PAYLOADS/EXPERIMENTS	Disaster Assessment							OCCUPATIONAL SKILLS		Electrical Technician	Radio Engincer	Instrumentation Technician	Optical Technician	Surveyor, Geodetic	Ceologist	Geophysicist	Meteorologist	Calibrator	Camera Inspector	Inspector, Systems	Electronics Mechanic	Special Spaceflight Skill			
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	Mission Events Evaluator **	11		$\Box$	$\bot$	Ţ	Ţ	$\Box$			L	П	I	$\perp$	$\perp$	Ţ	1	T	T	$\perp$	L	Ę			$\bot$	Ţ	I
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2095	Scanner Operation Monitor	91	Z		1		1							XI.	1	1	1							7	1	1	
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TABLE C-3: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-5 (Disaster Assessment).

(Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	Disaster Assessment							OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Radio Engineer	Optical Technician	-	Н	Geophysicist	Meteorologist	Weather Observer	Camera Inspector	Inspector, Systems	Electronics Mechanic	Special Spaceflight Skill			
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2140	Volcanic Eruption Data Observer									I					$\bigcirc$	$\bigcirc$	Ø				13					
2141	Forest Fire Data Observer					L	L		1		4	1				× .	$\geq 1$		<u> </u>							
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2143 2144	Landslide Data Observer Snowslide Data Observer	11 🐃	$\overline{\lambda}$		7	<u> </u>	32	8/1	¥	# : <b> </b>	4	2313	400	1	-		负	4		12	12	$\vdash$	H	4	72	-
2145	Land Subsidence Data Observer		Ħ	-+	+	+-	1	+	$\dashv$	}	+	+	+	+	H	$\dashv$	紛	+	十	+	+-	$\vdash$	+	-	+	+
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2147	Blizzard Data Observer		$\triangle$		1	L						I	I	I				9					$\Box$	I	I	$\Box$
2148	Hurricane Data Evaluator		$\triangle$		1	-	-		]		_		1	1			8	9	QL	_	1		1		1	Ш
2149	Tornado Data Evaluator	l c			4	-	H	4	4	1	4	4	1	4						<u> </u>	1		$\vdash$	4	1.	Li
2150	Tidal Wave Data Evaluator		兴		+	+	H		4	٠,	-	+	+	╀	-					╂	+		-	-	+	-
2151 2152	Flood Data Evaluator  Volcanic Eruption Data Evaluator			-	-	+-	+-	-+	4	ŀ	-		+-	╁		Ö		약	4	┼	┼-	-	-			-
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2156	Snowslide Data Evaluator				$\perp$				]		$\Box$	I	I				X		$\supset$				$\Box$	I	L	
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2163	Topographical Precursor Observer								]	Ē							21	1					工	I		
2164	Precursor Disaster Observer		$\Box$					$\perp$			$\perp$	1	1	_	$\Box$	_	X	_	$\perp$	<u> </u>	Ш		$\perp$	丄	$oldsymbol{oldsymbol{oldsymbol{eta}}}$	Ш
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TABLE C-3: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-5 (Disaster Assessment). (Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	Disaster Assessment							TIONAL	General Lechnical Skill	Padia Engineer	Instrumentation Technician	Optical Technician	Surveyor, Geodetic	Geologist	Geophysicist	Meteorologist	Weather Observer	Calibrator	Inspector Systems	Electronics Mechanic				
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TABLE C-4: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-1 (Biological Experiments).

	TASK - SKILL	PAYLOADS/EXPERIMENTS	MS-1(1) Separation of Biologicals						SODE COCUBATIONAL SKILLS	Constant Tocking	181 Flectrical Technic	187	$\vdash$	+	884 Calibrator	722 281 Inspector Systems	6. 201 Electronics Mechanic	<b> </b>							
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1170	Power Conditioning/Distribution System Stowers				1			1		_		-	<b>Ø</b> J.	4	1	4-	1	-		_	1	-		1	1-1
1179	Power Conditioning/Distribution Sys. Con. Actuator Sample Holder Installer				-	-			4	-	-		쁫	-	+	+-	╀	-	-+	-	-	$\vdash$	+	+	╁
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	rimary Occupational Skill. 🔯 = Mission Occupational Sk				_							_	_	_					_	_	_				-



TABLE C-4: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-1 (Biological Experiments).

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-	TASK - SKILL	PAYLOADS/EXPERIMENTS	Separation of Biolo	;						OCCUPATIONAL	General Technical	Electrical Technician	Radio Engineer		Calibrator	Inspector, Systems	Electronics Mechanic	Special Spaceflight Skill							
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TABLE C-4: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-1 (Biological Experiments). (Continued)

·	TASK - SKILL	PAYLOADS/EXPERIMENTS	Separation of Biologicals							OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Biochemist	Callgrator	Flectronics Mechanic	Chocial Conceptions Chill	Special spacehight skill								
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TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-2 (Levitation Experiments)

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	TASK - SKILL	PAYLOADS/EXPERIMENTS	Preparation of Glasse	Supercool'a/Homog, Nuclea	Crystal Growth/Solutions				OCCUPATIONAL	General Technical Skill	Electrical Technician	Radio Engineer	Metallingist Assistant	Chemist, Inorganic	Chemist, Physical	Calibrator	Inspector Systems	Electronics Mechanic							
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0393	Calorimeter Control Deactuator				$\perp$				]			Į.	1			1	1	1	土	П	口		土	上	
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TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-2 (Levitation Experiments) (Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	paration of Glasses	Supercool'o/Homoo Nuclea	Crystal Growth/Solutions						TIONAL	Ceneral Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Metallurgist Assistant	Chemist, Inordanic	Chemist, Physical	Calibrator	Inspector, Systems	Electronics Mechanic							
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1097	VHF Power Unit Calibrator			$\triangle$	$\bar{\triangle}$			_	_	7	ľ	T			_†	<u></u>	T	_k	t	<b>b</b>	↲	1	T			_†		_ -
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1145	Heat Rejection System Stower		$\stackrel{\wedge}{\downarrow}$					_		]			_	_	4	1	1	1	1	4	_	-	_	Ш	_	_	_	4-
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1160	Computer Stower		H	$\forall$		-	-+	-	+	+	1	+	7	16	<del>}</del> - [5	+	╁	+	+-	+	+		-	$\vdash$	-	+	+	+
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1163	Power Conditioning/Distribution System Unstower		$\bar{\triangle}$					1	I	]		I	I	$\mathbb{Z}$		L	L	L	I	I	I				I			I
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1211	Atmosphere Analysis Unit Repairer		R			+	+	+	+	┪┈	+	+	+	+	+	+-	+	+	+	卜	-	$\vdash$	-	+	+	+	+	+
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	Viewing Device Translocator		$\triangle$	$\triangle$			I	I	I	1		7	I	12	1	L	Ĺ	Ĺ	L	Ĺ	L				_[	_[	1	1
1217	Viewing Device Installer	1 /	Ŋ	$\Delta$	Ľ√l	- f	- 1	- [	1	1	- 1	-10	)[	1>	(I	1	1	ł	1	1	1	, 1	. 1	- 1	L		┸	



TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-2 (Levitation Experiments) (Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	Preparation of Glasses	Supercool'g/Homog. Nuclea.	Crystal Growth/Solutions					3 11 12 14 14 01 1 JO	OCCOPATIONAL SKILLS	Ceneral Technical Skill	Electrical Technician	hadio Engineer	Metallurgist Assistant	Chemist Inordanic	Chomist Obusinal	Calibration	Increase Succession	inspector, Systems	Electronics Mechanic								
		PA	MS-2(1)	5-2(2)	MS-2(3)					100	7000	000.000	3. (81	003.107	011 281	022.081	00 2 200	710 000	722 281	107.7	8.281								
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1219	Viewing Device Stower Viewing Device Fault Identifier			씃	$\times$			4	4	-18	-	+	+	4	2 _	-	1		+			+-	13				Н		۲
1223	Viewing Device Repairer		$\overline{}$	$\overline{\Lambda}$	H			+			-	+	+	+		1	+	+	+	K	矛	1	1	1	-		┢═╂		
1226	Camera Translocator				Ø	2		1	1		t	7	j.	]>	ব	1		Ť	1	ŕ	1	1	T	1					
1227	Holographic Device Calibrator	1		$\triangle$	$\triangle$				I	]	L	I	I	İ	I	I	I	C	I	$\triangleright$	1	I	I	I			口		
	Holographic Device Operation Monitor		Щ	Ň	Á	_	-	_[	1	4	L	1	4	1	<u>J</u>	1	1	Ļ	1	1	4	$\perp$	+-	$\perp$	$\Box$	П	Ц		
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1235	Holographic Device Stower			Δ	$\triangle$	_	4	_	$\perp$	]	L		7	S	1	_	L	1	L	1	1	1	_		Ш				لسا
	Holographic Device Remover			4	$\langle \cdot \rangle$		_	_ _	_	4	_	- 12	}	$\downarrow$	<b>J</b>	-	↓.	4.	1	-	4	╁-	<del> </del>	1	Щ	-	1-1		
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	Holographic Device Translocator  Holographic Device Unstower		人	Ā	N	$\dashv$	$\forall$	_	+	1	r	4	+-	K	*	╁╴	†	†-	$\dagger$	†	+	+	+	+		$\vdash$	П		
	Heating/Cooling Device Operation Monitor				$\overline{\Lambda}$		7	1	†	1	1	1	1	1	1	T	1	1	+	1-	$\top$	$\top$				П			$\neg$
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1245	Heating/Cooling Device Repairer Heating/Cooling Device Fault Identifier		<b> </b>		$\frac{\langle \cdot \rangle}{\langle \cdot \rangle}$	-	4	4	+	١.		4-	+	4-	ļ.,	-	Ļ	↓-	↓	R	욁_	-	╀-	<b>↓</b>					Щ,
1250	Heating/Cooling Device Remover		$\vdash$	-	X	-	+		┿	4	+	t	╬	七	╁╴	╀╌	+	+	+	12	4	+-	┼	╁┤	-	H	+	-	$\dashv$
1251	Heating/Cooling Device Installer		$\vdash$		刁	+	寸	-+-	+-	1	-	Ť	1	K	-	+-	+	十	╁	-	+	+	+-	+-1		1	_	$\neg$	
1254	Metal Sample Installer			$\triangle$				I	Ι	]		ľ		I	1/2			I	I	I	I	I							
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1256 1257	Metal Sample Translocator  Metal Sample Unstower		$\vdash$	싔		-	+	+	- -	4	F	4	+	K	}-	-	-	+	╀	+	+	┼	⊢	╁┵	$\vdash$	$\vdash$	$\dashv$		_
1259	Heating/Positioning Coil Operation Monitor		$\forall$	$\forall$	$\forall$	+	+	+	╁	$\dashv$	-	╁	╁	∜	+	$\vdash$	-	+	╁╌	+-	+	+	-	╁╌┤	$\vdash$	Н	$\dashv$	$\dashv$	
1260	Heating/Positioning Coil Control Actuator		N	$\overline{\Delta}$	$\overline{\Delta}$	-+	+	+	十	1	$\vdash$	t	$^{+}$	K	1	-	╁	+-	†	十	+	+-	┢	H	Н	П	7	-	$\dashv$
1263	Heating/Positioning Coil Repairer		$\triangle$	$\triangle$	N	1	7		†	1		1	T							3	₫	T						$\Box$	
1264	Heating/Positioning Coll Fault Identifier		A	$\triangle$	$\triangle$	$\Box$		I	I	]		I	I	Ţ	J.		L	L	L	2	\$			Ш			$\Box$	_	
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1271	Heating/Positioning Coil Unstower		$\triangle$	$\triangle$	$\triangle$					] `		I	I	$\triangleright$			L	L		L	I			口	$\Box$	$\Box$	$\Box$	$\Box$	
1333	Heating/Positioning Coil Calibrator			$\triangle$	싀	]	$\perp$	$\perp$	L	]		L	L	L	<u>. _</u>	_	Ļ.	C	1_	12	1	ــــــــــــــــــــــــــــــــــــــ		Ш	Ш	_	4	4	_
1336			4	싞	싀	4	4	4	1	-	L	$\perp$	$\perp$	N N	_	<u> </u>	┞-	+	├-	<del> </del>	+	⊬	-		$\vdash$	$\dashv$	4	-	4
1341	Metal Sample Stower Atmosphere Analysis Unit Operation Monitor		$ \cdot $	H	서	+	+	-	╁	┨	-	╁	╁╴	1	1	$\vdash$	╁╌	╁	+	╁	+	╁╾	H	H	-	-	十	$\dashv$	$\dashv$
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1355	Materials Sample Translocator			$\triangle$	囚	I	1		I	]				$\triangleright$						I	I					$\Box$	$\Box$		
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	Crystal Growth Observer Crystal Growth Process Evaluator		-		岔	+	+	+	T	1	+	$\dagger$	†	1	T	Ŏ	Ź	1	1	T	+	1	Н	$\sqcap$	7		7	7	$\dashv$
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1371	Materials Sample Stower			$\triangle$	$\triangle$	I	Ţ	I	L	1		L	$\bot$	$\mathbb{Z}$	L	Ĺ	Ĺ	L	L	Ĺ	丰	$\perp$	$\sqcup$		[	1	4	4	_
	Silicate Melt Suspector Control Actuator			_[	4	4	4	4	1	<b></b> .	1	4	1	¥,	-	_	-	-	<del> </del>	+	+	+	$\vdash$	$\vdash \vdash$		4	4	4	
	Silicate Melt Susceptor Unstower		*	-	-	+	+	+-	+-	1	-	+	+	₩	+	-	-	+	+-	+	+	+	⊢	Н	$\dashv$	+	+	+	-
	Silicate Melt Susceptor Translocator Silicate Melt Susceptor Installer		7	+	+	+	+	+	+	1	1	1	+	쉲	<del> </del>	-		+	+	+	+-	1-	$\vdash$	-		+	十	+	-
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TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortic Lab Payload MS-2 (Levitation Experiments) (Continued)

1378   Silicate Meth Susceptor Module Installer																											
17   17   17   17   17   17   17   17		TASK - SKILL	'LOADS/EXPERIMENTS	Preparation of Glasses	Supercool'g/Homog. Nuclea.	Crystal Growth/Solutions					OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Chemist Ingraphic	Chemist Diversal	Calibrator	Inspector, Systems								
1396 Silicate Melt Susceptor Regulator (1998)  1397 Crystal Foreward Research Faviluator (1998)  1398 Silicate Melt Susceptor Rapit Identifier (1998)  1398 Silicate Solvent Applier (1998)  1399 Furnace Centrol Decelutator (1998)  1390 Furnace Centrol Decelutator (1998)  1390 Furnace Centrol Decelutator (1998)  1390 Furnace Centrol Decelutator (1998)  1391 Crystal Puller Unatowor (1998)  1392 Crystal Puller Unatowor (1998)  1393 Crystal Puller Unatowor (1998)  1393 Crystal Puller Installer (1998)  1393 Crystal Puller Departien Monitor (1998)  1493 Crystal Puller Puller Source (1998)  1493 Crystal Puller Puller Source (1998)  1494 Crystal Growth Structure Analyzer (1998)  1495 Crystal Growth Structure Analyzer (1998)  1496 Crystal Growth Structure Analyzer (1998)  1497 Materials Analysis Equipment Tester (1998)  1498 Crystal Growth Structure Analyzer (1998)  1499 Calorimeter Researce (1998)  1490 Calorimeter Researce (1998)  1491 Calorimeter Researce (1998)  1492 Calorimeter Researce (1998)  1493 Frietion Measuring Device Repairer (1998)  1494 Frietion Measuring Device Repairer (1998)  1495 Frietion Measuring Device Repairer (1998)  1496 Frietion Measuring Device Repairer (1998)  1497 Frietion Measuring Device Repairer (1998)  1498 Frietion Measuring Device Repairer (1998)  1499 Frietion Measuring Device Repairer (1998)  1499 Frietion Measuring Device Repairer (1998)  1499 Frietion Measuring Device Repairer (1998)  1499 Frietion Measuring Device Repairer (1998)  1499 Frietion Measuring Device Repairer (1998)  1491 Frietion Measuring Device Repairer (1998)  1493 Frietion Measuring Device Repairer (1998)  1494 Frietion Measuring Device Repairer (1998)  1495 Frietion Measuring Device Repairer (1998)  1496 Frietion Measuring Device Repairer (1998)  1497 Frietion Measuring Device Repairer (1998)  1498 Frietion Measuring Device Repairer (1998)  1499 Frietion Measuring Device Repairer (1998)  1499 Frietion Measuring Device Repairer (1998)  1499 Frietion Measuring Device Repairer (1998)  1490 Frietion Measuring Device Re			PAY	-2(1)	-2(2)	-2(3)					ODE	. 000	. 181						281								
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1388   Silicate Solvent Applier   1400   Furnasc Control Deckutator   1401   Silicate Melt Susceptor Operating Monitor   1415   Crystal Puller Centrol Actuator   1415   Crystal Puller Centrol Actuator   1416   Crystal Puller Circuit Actuator   1417   Crystal Puller Installer   1417   Crystal Puller Installer   1418   Crystal Puller Installer   1419   Crystal Puller Cleaner   1419   Crystal Puller Cleaner   1419   Crystal Puller Cleaner   1419   Crystal Puller Cleaner   1419   Crystal Puller Cleaner   1419   Crystal Puller Cleaner   1419   Crystal Puller Repaired   1419   Crystal Puller Cleaner   1419   Crystal Crystal Puller Repaired   1419   Crystal Growth Structure Analyzer   1419   Crystal Growth Structure Analyzer   1419   Crystal Growth Characteristics Determiner   1419   Crystal Growth Structure Analyzer   1419   Holographic Device Tester   1419   Holographic Device Tester   1419   Holographic Device Tester   1419   Holographic Device Tester   1419   Holographic Device Tester   1419   Holographic Device Device Puller   1419   14			1	炔			4	4	44	$\vdash$				4	4	1 ×	12	1		KS,	2	4	4	13		$\dashv$	4
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1301. Silicate Melt Susceptor Operating Monitor			1			Z	+	+		H	200		-	- 5	al a	1		1	1		-	+	+	+	1	7	4
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1913   Crystal Puller Irstaller   1913   Crystal Puller Remover   1914   Crystal Puller Remover   1915   Crystal Puller Cleaner   1915   1915   Crystal Puller Cleaner   1916   1915			]]			$\triangle$	_	1	П	Ц				_[]	<u> </u>	1	L	L	_		Ц.	4	$\perp$	1	$\perp$		1
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1495   Crystal Growth Structure Analyzer   1497   Materials Analysis Equipment Tester   1499   Holographic Device Tester   1499   Holographic Device Tester   1494   Calorimeter Remover   1495   Crystal Growth Data Recorder   1496   Calorimeter Remover   1498   Calorimeter Remover   1498   Calorimeter Installer   1498   Calorimeter Unstower   1492   Calorimeter Unstower   1493   Friction Measuring Device Repairer   1493   Friction Measuring Device Gault Identifier   1498   Friction Measuring Device Gault Identifier   1498   Friction Measuring Device Gault Identifier   1498   Friction Measuring Device Calibrator   1491   Friction Measuring Device Calibrator   1492   Friction Measuring Device Remover   1493   Friction Measuring Device Installer   1493   Friction Measuring Device Installer   1494   Friction Measuring Device Control Deactuator   1495   Friction Measuring Device Control Deactuator   1496   Friction Measuring Device Control Advance   1497   Friction Measuring Device Control Advance   1498   Friction Measuring Device Control Advance   1499   Friction Measuring Device Control Advance   1499   14				┝	Н	슀	-	+	+	H		-+	+	-+-	+-	1	ᡮ	╀	-	ž	-		+	+	+	+	
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1497   Friction Measuring Device Stower					$\overline{\Delta}$	$\dashv$	+	十	Н	$\dashv$	**	-	+	- 5	ð	-	1	-	H		_	+	+	<del>-</del>	17		11
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🔘 = Primary Occupational Skill. 💢 = Mission Occupational Skill. 🔯 = Task-Skill Required by Payload/Experiment.	1572	Glass Processing Research Evaluator					工	1	П	1		1	1	1	I	C	X				I	I	I		口	I	$\Box$
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TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortle Lab Payload MS-2 (Levitation Experiments) (Continued)

CODE  TITLE  1898 TV Sestem Control Actuator  1896 A Decompression Editionment Control Actuator  1896 A Decompression Editionment Control Actuator  1896 A Decompres Suinal Vacciner of System Inspector  1897 Autocomplex Suinal Vacciner of System Inspector  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decoulator  1898 TV System Control Decomplex System Inspector  1898 TV System Control Decomplex System Inspector  1898 TV System Control Decomplex System Inspector  1898 TV System Control Decomplex System Inspector  1898 TV System Control Decomplex System Inspector  1898 TV System Control Decomplex System Inspector  1899 Type System Inspector  1898 TV System Inspe		TASK - SKILL	PAYLOADS/EXPERIMENTS	11		- 1					OCCUPATIONAL SKILLS	-	+	+	Instrumentation   echnician	+	╁	╁	╀╌	Flectronics	Н							
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TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-2 (Levitation Experiments) (Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	Preparation of Glasses							OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical	Calibrator	Inspector, Systems	Electronics Mechanic							
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2303 2304	Crystal Growth Research Monitor  Materials Dopant Translocator	1	1		炽		4	<u></u>	4	∤∷	-	-		$\otimes$	4	4	4	+	4	3	4	12		4	+	+	4
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TABLE C-6: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-3 (Furnace Experiments).

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0977 Composite Materials Sample Remover 0978 Composite Materials Sample Stower	╢.	싅	H	$\dashv$	4			de	ŀ	F	)	X	-		$\dashv$		1	+			+	+-	H	t
1980 Furnace Unstower to Historian in You had the selection	31.						1	1				X					1	土						
981 Furnace Modula Remover			$\mathbb{R}$		1			4	<u> </u>	<u> </u>	<u>}</u>	X	:		-		4	-		-		-[	$\vdash$	
982 Furnace Module Installer 983 Furnace Stower	-			-+			-		H		+			+		+	-	+-				+	$\vdash \uparrow$	-
984 Furnace Cleaner	71		$\triangle$	1	Ï			]	Ţ	T	I	Ø		$\Box$	7		Ţ			7		$\Box$	П	工
0985 Furnace Operation Monitor 0988 Furnace Repairer	-		刽	-	+	$\dashv$		$\dashv$	+	+	+	(X)	-	+	+	+	8	1	Н	+	+	+-	$\vdash \vdash$	+-
989 Furnace Fault Identifier	1		Ź	_	+		$\pm$	1	E	$\pm$	İ			1			Ŕ	Ì		士		士		土
991 Mixing Unit Installer	긔[	$\Box$	A		5 ?		-	٦		C				+		3 J.S	12.	1	-3	<del>.  </del>	-	+		+
0992 Mixing Unit Unstower 0993 Mixing Unit Translocator	-	N	N	+	+	H			k	5			1	+			+			+	:[:		$\Box$	+
1994 Mixing Unit Remover of the Albert Action of the Section					1			]	ζ		1	X	$\Box$	1	1	T	T	T		7	1		П	T
1997 Mixing Unit Stower 1998 Mixing Unit Cleaner	-	H	$ \cdot $	-	+			4	H	+	+	8	-	+	+	+	+-	-			+	+-	-	-
1999 Mixing Unit Operation Monitor	1		过		#			<b></b>	Ľ	Ï		Ø		1	1	1	1	Ė		$\Box$	1	П	口	工
1002 Mixing Unit Repairer	-		읝	4	4	<del>                                     </del>	+	4	-	+	1	$\dashv$		+	+	+	0		$\vdash$	+	+	+	H	+
1003 Mixing Unit Fault Identifier 1016 Materials Forming Equipment Installer	$\exists$	因	团	+	+	H	_	1	卜	to	$\pm$	X	_	_	$\exists$	<u></u>	ľ	$\pm$		1	士	$\forall$	H	土
017 Materials Forming Equipment Unstower	][		77	1	1			٦.,	Ţ		L	Ø	$\Box$	$\downarrow$	1	7	Ţ	$\Box$	П	Ţ	$\bot$	$\Box$	耳	<del></del>
1018 Materials Forming Equipment Translocator			宗	+	+	╁╌┤	+	4	F	4	╁		+	$\dashv$	+	+	+	+	$\vdash \vdash$	+	+	+	$\vdash \vdash$	+
1021 Materials Forming Equipment Cleaner 1046 Materials Analysis Equipment Calibrator			-1	1	1	廿	土	1		士			士	1		I	$\triangleright$				1	口	口	工
048 Materials Analysis Equipment Cleaner				Ţ	1			1		4_	1	$\Sigma$	रूने	$\prec$	4	+	+	4-		-	+	+	┝╌┝	
19491 Materials Analysis Equipment Controller D= Primary Occupational Skill. (X) = Mission Occupational S		لايد ۱۸		<u>l</u>		لسا		<u>ــــــ</u>		٠.	٠.	<u>ئىت</u>	المحد	تلائم	علد		٠.		4			لببا	سلسا	



TABLE C-6: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-3 (Furnace Experiments).

(Continued)

TASK - SKILL	A Y LO A D S / E X P E R I M E N T S	Composite Materials	Liquid Dispersions						OCCUPATIONAL SKILLS	General Technical Skill	.2	Kadio Engineer	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical		Systems	Electronics Mechanic						
	M	MS-3(1)	3(2)						CODE	000.000	003.181	003 781	011.281	022.081	022.081	710.884	722.281	187						
CODE TITLE		N.S.	MS-						ŭ	000	603		1-	022	022	710	22.	878						
1054 Computer Unstower												10	1											
1055 Computer Operation Monitor						I					4	Ę				1	T					П		
1058 Environmental Chamber Unstower 1059 Environmental Chamber Module Remover		$\vdash$				-	-	Н				18 8				4		1	1			11		
1060 Environmental Chamber Module Installer						1					ð	ΪŹ												
1061 Environmental Chamber Stower		$\triangle$		П	$\Box$	Ŧ	1	П		П	7	- 12	1		П	Ŧ	Ţ	Ŧ	$\vdash$		$\top$	$\Box$	$\perp$	$\bot$
1062 Environmental Chamber Cleaner 1065 Environmental Chamber Repairer		X	쉱	$\vdash \vdash$	+	+	+	Н		$\vdash \vdash$	+	18	4-	H	$\vdash$	+	18	ᇷ	+	Н	+	+1		+-
1066 Environmental Chamber Fault Identifier			$\triangle$			1					$\perp$		İ			1	Š	Ž.			士		士	
1079 Vibrator Installer		$\subseteq$	$\stackrel{\wedge}{\sim}$		+				1000		9	- <u> </u>	1		778			-	0.0		27 1		-	
1080 Vibrator Unstower 1081 Vibrator Translocator			$\tilde{\Lambda}$	3	+	+	-	Н				弋	1-	-		+	+	+	-		+	+		+
1082 Vibrator Remover					1	1					a	ĺχ	1					1				11		
1085 Vibrator Stower					$\Box$	I	L				I	3	<u></u>			$\Box$		I			$\top$			
1086 Vibrator Operation Monitor 1089 Vibrator Repairer		X	份	-		+	+-	H	34.	$\vdash$	+	- 12	-	$\vdash$		+	3		-			1-1	4	4-
1090 Vibrator Fault Identifier	l	$\overline{\triangle}$	$\overline{\Lambda}$	1	_	+	T	Н			_	+	+	Н		-		計			_	11	+	+-
1091 VHF Power Unit Installer	ll	$\triangle$	$\triangle$									$\geq$	1			$\perp$	1	T			$\perp$			
1092 VHF Power Unit Unstower 1093 VHF Power Unit Translocator		$\frac{1}{2}$	$\frac{4}{2}$		-	+	+	$\vdash$				8	4	Н	-	$\dashv$	+	+	-		+	$\vdash$	+	+-
1094 VHF Power Unit Remover		H	$\overline{\lambda}$		77 13	+	18		: J	4	at	☆	1		2	+	+	+	100		+	1-1		+-
1095 VMF Power Unit Module Remover											<u>o</u> t	$\mathbb{X}$						I						
1096 VHF Power Unit Module Installer (1998) (1997) (1997)			$\triangle$	_		L	-				긔	X	1									-		-
1098 VHF Power Unit Stower 1099 VHF Power Unit Operation Monitor		$\mathbb{R}$	$^{\wedge}$	-		-	+	-				150	-		-	-	+	+	Н		+		-12	-
1102 VHF Power Unit Repairer	11	$\triangle$	$\overline{\Delta}$	-	+	+-	+		334	+	-		1			+	12	al-			1		$\top$	1
1103 VHF Power Unit Fault Identifier			$\triangle$	$\Box$	$\perp$	I											Ø	<u> </u>	П		I	П	$\Box$	I
1105 Dispersion Control System Unstower 1107 Dispersion Control System Stower		炰	싂		-	4-	+-			-	-	18	-	$\vdash$		-	+	+	Н	$\dashv$	+	-		-
1107 Dispersion Control System Stower 1109 Dispersion Control System Cleaner	-	H	$\forall$	-		+-	+	Н	٠	-		台	-	Н	$\dashv$	+	╁	+	Н	+	+	╀╌┼	+	+-
1110 Dispersion Control System Operation Monitor	1	囚	囚					200				Ŏ.			3		1						1	
1113 Dispersion Control System Repairer			A	Ţ		I					1	1					. 6	<u>.</u>				$\Box$		
1114 Dispersion Control System Fault Identifier 1115 Slip Cast Injection System Installer		H	$\forall$	1	4	+				-	4	+				+	10	4-		-		$\vdash$		+-
1116 Slip Cast Injection System Unstower			$\overline{\Delta}$	+	#	1	18			Ť						+	1	1				11		
1117 Slip Cast Injection System Translocator			$\triangle$			I				Q.	I	$\times$			$\Box$	I	I			$\Box$	$\perp$	П	$\bot$	$\Box$
1118   Slip Cast Injection System Remover     1122   Slip Cast Injection System Operation Monitor		H	$\frac{2}{2}$	+	-	+-	$\vdash$	Н	- }	{	4	Ķ	-	$\left  \cdot \right $	-	+	╀	╁	H	+	+-	╁┼	+	+
1125 Slip Cast Injection System Repairer			$\forall$	+	+	╁	╁	Н	ŀ	-	+	10		H	+	+	6	<del>/</del>	Н	+	+	$\vdash$	+	+
1126 Slip Cast Injection System Fault Identifier				士													Ź	1		$\perp$				
1127 Atmosphere Supply/Control System Module Remover		$\mathbb{A}$	4	4		10				4	્રા_	X					4.	4-		4		1		-
1128 Atmosphere Supply/Control System Module Installer 1129 Atmosphere Supply/Control System Operation Monitor		N	$\forall$	+	+	+-		-	ै		2 -	X	-			+	+	+		+	-	1-1	-	+
1132 Atmosphere Supply/Control System Repairer:	1	N		_	_	I						Ľ	3				G	-		1				
1133 Atmosphere Supply/Control System Fault Identifier 8 %				1	1						$\downarrow \Gamma$	4	ે	Ц	II.	-	Œ	4_	-	4		H	-	4
1134 Power Conditioning/Distribution Sys. Module Remover 1135 Power Conditioning/Distribution Sys. Module Installer		怾	쏬	+	+	+-	+	H	ŀ	-{	<del>* -</del>	校	H	$\vdash \vdash$	$\dashv$	+	+	+	H	+		++	+	+-
1136 Power Conditioning/Distribution Sys. Module Installed		N	团	_+	+	$\pm$		H	Ì	<u> </u>	$\pm$			口	士	士		$\perp$		$\exists$		$\Box$	士	
1139 Power Conditioning/Distribution System Repairer		$\Box$	Ă	$\Box$	T	L	П			J	1	1			4	1	100		$\sqcup$	4	4	$\sqcup$	+	+-
1140 Power Conditioning/Distribution Sys. Fault Identifier	ļ,	兴	$\mathbb{H}$	+	4	+	$\vdash$			+	+	10	-	$\vdash$	+	+	18	4	<del>     </del>	-	+	+-+		+-
1141 Environmental Chamber Operation Monitor		Ιŷ	47	-+		+-	1-1	-	•	+	+	K	Н	H	$\dashv$	+	1-	1	H	+	1		+	
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1142 Heat Rejection System Unstower			\ \ \		1						1						, S	8					‡	



TABLE C-6: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-3 (Furnace Experiments).

(Continued)

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	TASK - SKILL	PAYLOADS/EXPERIMENTS	Composite Materials	Liquid Dispersions						OCCUPATIONAL SKILLS	Control Control	Flortrical Technician	Radio Fnoincer	Instrumentation Technician	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical		Inspector. Systems	Electronics Mechanic							
		PAY	3	2						CODE		200	187	281	281	180	081	384	52	281	T				T		T
CODE	TITLE		MS-3(1)	MS-3(2)						၂၀		000.000	003 187	003.281	011,281	022,081	022,081	710.884	722.281	828.281							
	Heat Rejection System Fault Identifier			M							1								Ì	Ø							
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	Atmosphere Supply/Control System Unstower		Ō			: ::	1		-	1	-				ं							1	1-		+		
	Power Conditioning/Distribution System Unstower		Ø					4	1	]				Ø	3.	া		4	1							I	
-	Atmosphere Supply/Control System Stower Power Conditioning/Distribution System Stower		X		$\vdash$		+	+	+	-	-	+	+-	8	-	4		+	+	+	+-	$\vdash$	$\vdash \vdash$	${oxed}$	+	+	+
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1174	Atmosphere Supply/Control System Control Actuator			N			士	$\pm$	士	1		1	I	$\bigotimes$	_	_	_	士	$\pm$	士	$\perp$	1			士	士	
1175	Furnace Control Actuator			松			$\bot$	$\Box$		]	F	L	Ļ	$\boxtimes$	J	$\Box$	$\supset$		$\prod$	Ţ	I	Ę	П	$\Box$	I	Ţ	$\vdash$
1176	Dispersion Control System Control Actuator Mixing Unit Control Actuator	j.	-	紟			4	<u></u>	-	4	-	+	-		ᅇ		-	-	+	- -	+-	ļ	$\vdash$	1		+	-
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1183	VHF Power Unit Control Actuator			Ō			7	+		1		1		(X)	7	7	7	_	+	7	+	1	1-1		1	1	
1184	Heat Rejection System Control Actuator			会			4	Ţ	Ţ	] :		F	L	$\otimes$	7	7	4	1	1		1	L			1	Ţ	$\perp$
1195	Camera Repairer Atmosphere Analysis Unit Unstower		$\lambda$		H		+	+	╁	┨	-	╁╌	╀	X	+	+	-	+	- 15	4	+-	-	╌╢	-+	+	┿	╁╌
	Atmosphere Analysis Unit Translocator		X	-	-	$\dashv$	+	+	╁╌	1	<b> </b>	+	$\vdash$	$\stackrel{\sim}{\nabla}$	+	+	-	+	+	+	+	+-	H	-	+	+	+-
1205	Atmosphere Analysis Unit Installer		Z				1			1	Ľ	O		X							1	L				上	
	Atmosphere Analysis Unit Remover					_	-	-	1	1	_	C	1_	$\propto$	_	4	-	_	1	1	-	_			4	_	1
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	Atmosphere Analysis Unit Module Installer		Z				+	+	-	-	<b>-</b>	ŏ		Ż	+	+	+	+	7	+	+	-		+	+	+	
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1226	Atmosphere Analysis Unit Control Actuator Camera Translocator			$\forall$	$\vdash$	$\dashv$	$\dashv$	+	+-	┨	6	+	Н	\$	$\dashv$	+	+	╬	+	+	╁╌		$\vdash$	$\dashv$	+	╁	H
1229	Holographic Device Control Actuator	l		$\overline{\triangle}$	$\Box$			$\top$	T	1	ř	+		$\overline{\mathbb{X}}$	7	+	+	+	+	+	1		Н			T	$\Box$
1232	Holographic Device Repairer			$\triangle$			I	I	I	1		L				I			Ì	1	I			$\Box$	$\perp$	I	
1233	Holographic Device Fault Identifier Holographic Device Remover	l		$\dot{\mathbb{R}}$		-	-	-	+	↓.	-		-	J	-	+	-	,- -	- 18	4	╁_	-	-		+	+-	$\vdash$
1238	Holographic Device Installer			$\mathbb{R}$		-	+	+	+	1	-	Ö		$\forall$	+	+	-†	+	+	+	†-	-	$\vdash$	+	4	+	H
1239	Holographic Device Translocaton			Š					T	1				X	1	1	1	1	1	1							
1240	Holographic Device Unstower			$\frac{1}{2}$		_	1	1	L	]	_			Ø	3	1	4	1	1	4	ļ		$\Box$	-	4	-	1
1255	Metal Sample Installer		-	$\stackrel{\triangle}{\times}$	-	-		4	+	1	H	-			(X) (X)	+	+	+	+	+	┢		-	+	+-	<del>-</del>	H
1256	Metal Sample Translocator		H	Ħ	$\dashv$	+	+	+	十	1	0	-	Н	ХÏ	4	- -	$\dagger$	+	+	+	$\vdash$	H	$\vdash$	-†	+	+-	H
1257	Metal Sample Unstower			$\triangle$			I			]	Ĺ			8										1	I	I	$\Box$
1259	Heating/Positioning Coil Operation Monitor			$\mathbb{R}$	_	4	_	-	1_	-		_			4	+	4	- -	_	4	ـ		4	-	+	╁	┦
1260	Heating/Positioning Coil Control Actuator Heating/Positioning Coil Repairer	ŀ	┝╢	$^{\wedge}$	-		3 3	7	+	1703	-	12	$\vdash$	×	+	+	+	+	te	<del>a</del> -	+-		$\dashv$	+	+	+-	-
1264	Heating/Positioning Coil Fault Identifier(1988年)			Ã		7	-		+	1	H				7	+	+	+		Ť					1	I	
1268	Heating/Positioning Coil Remover							1		1	E	$\bigcirc$		X	Ţ	I	Ţ		I	I				1	Ţ	L	
1269	Heating/Positioning Coil Installer			$\stackrel{\triangle}{+}$	-	-	+	+	<del>  -</del>	1		$\circ$	$\vdash \vdash$	⇍	4	+	+	+	+	+	-		+		+-	+-	Н
	Heating/Positioning Coil Translocator。 学家 中央 中央 中央 中央 中央 中央 中央 中央 中央 中央 中央 中央 中央	1		$\langle \cdot \rangle$	+	-	+	+	+-	1.00	۲		Н	쉾	+	+	+	4-	+	╁	+	Н		+	+-	+	-
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	Atmosphere Analysis Unit Operation Monitor		$\triangle$	$\overline{\lambda}$	1	7	Ţ	Ŧ	F	1	F	П	$\sqcup$	<u> 27</u>	Ţ	1	1	$\bot$	Ŧ	Ŧ	$\vdash$	Ц	4	4	$\perp$	<del> </del>	Н
	Liquid Dispersion Research Planner		$\vdash \vdash$	쓹	+	+	+	+	┼-	-	$\vdash$	-	Н	{}	<b>X</b>	+	+	+	+	+	+-	$\dashv$	+	+	+	+	H
	Slip Formulation Controller Slip Materials Stower			T	$\dashv$	+	+	-	<del> </del>	<b>†</b>	1	H		জ্ঞ	-	+	$\dagger$	1	†	+			_	_	1	T	Ħ
1351	Slip Materials Remover			A			I	I		1					3	J.	I	1	I	I			I	I	I	L	
1353	Liquid Dispersion Research Evaluator		$\sqcup$	Ķ	4	-	1	_	1	1	L		$\sqcup$	-4	4	4	+	+	+	+	1_	$\vdash$	-	-	+	+	Н
	Slip Casting Remover Slip Casting Stower		Н	4		+	+	+	+	1	-	$\vdash$	$\vdash$	ਨੀ	4	- -	+	+	+	+	+	$\vdash$	+	+	+-	+-	Н
	slip Casting Stower rimary Occupational Skill. $ \vec{X} $ = Mission Occupational Sk	لىسىق دا د	<u>ا</u>	التنا - ال	بليث	بلسيد. دا د د	<u>_</u>	1011	<u>.</u>	<u> </u>		ا الم	اسط اعدا	الاهة Da	سان داد	ulu act	_ <u></u>	<del>L</del>	ulu ori	me	nt.						ᅥ



TABLE C-6: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-3 (Furnace Experiments).

(Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	) Composite Materials	Liquid Dispersions	1					TA INCITA OF LOCAL	OCCOPATIONAL	+	+	Radio Engineer	+-	╁	Chamiet Physical	+	Inspector	Flectronics Mechanic	╁							
		<u>a</u>	NIS-3(1)	MS-3(2)						100	֓֟֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓	000.000	003.181	003.187	011 281	1.60	022 081	710 007	7 281	878 781	7							
CODE	TITLE		N	MS					ļ.,	1		3 3	00	8	3 6	5	3 5	7 1	7	1 6	3				$\downarrow$		$\perp$	
	Immiscible System Casting Stower Silip Cast Injection System Cleaner		<u>L</u> .		<u> </u>		4			4	ļ.	4	1			1	1	4	4	1	4					4	1	1
	Immiscible System Casting Remover		H					+	+	1	ŀ		+	-{}			+	+	+	1	1		33		4			d
1363	Slip Cast Injection System Controller			Z						1	ľ	1	1		Ĉ					1								
1447	Materials Analysis Equipment Tester					4	4	-[	4	4	Ļ	4	7	1	\$	1	1	4		42	1	<u>Je</u>			4		4	4
1448	Camera Tester Holographic Device Tester		$\vdash$	分	H	-	+	+	+-	1	-	-	4	- K	1	+	+	+	+	+	+	+	$\vdash$	$\vdash \vdash$	+	+	+	+
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1520	Data Recorder Translocator		厂				1	1	I	]		7	1	$\Box$		I	I	I	T	I	I		口	口	I	工	I	工
2240	Instrumentation & Control Center Unstower		侩			327	821	+	Ļ.	1		+	1	-12	<u> </u>	1			-	1-2	+	<del> </del>		100	-	$\perp$	+	4
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2252	General Purpose Lab Bench Unstower								L	]	Γ		I	Įį.				I		I	I				I	I	I	Ι
2253	Accident Control System Unstower		矣	$\Rightarrow$	H		+	+	+	-	1	4	4		<u>)</u>	+	1	+	+	+	+			-	-	-	+	+
	Instrumentation & Control Center Control Actuator General Purpose Lab Bench Stower		X	$\overline{\Delta}$	Н	$\dashv$	+	+	+	1	H	+	+	-18	#	╁	+	+	+	╁	+	╁─┤	Н	$\vdash$	+	+	+	+
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2265	General Purpose Lab Bench Fault Identifier General Purpose Lab Bench Repairer			X		$\rightarrow$		-	٠,	1	-	-	-	+	-	+	-	+	+	<u>S</u>				-	<del>.  </del>		+	+
2266	Accident Control System Fault Identifier			$\overline{\wedge}$		+	+	+		1	-	+	+	+	+	+	-	+	+	tô				$\vdash$	+	+	-	+
2268	Accident Control System Repairer										L		1		I			1		蔥	工	口			工	1	土	土
2269	Materials Analysis Equipment Inspector								_		_		1.		-	Į.	Ļ	4	S		1		$\dashv$	4	1		4	4
2270 2309	Holographic Device Inspector  Composite Materials Research Coordinator		$\overline{\wedge}$			-	+	4	+	{ ઘ	<u> </u>	-	+	+	·	+	+-	+	1	X	┰	$\vdash$	H	+	+	+	+	+
2310	Dispersion Control System Translocator			$\triangle$	1	+	+	+	+	1	1	d	+	1	1	+	1	+	+	$\vdash$	$\top$	1-1	$\sqcap$	$\uparrow$	+	+	+-	+
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2312	Dispersion Control System Remover		À	$\triangle$	$\perp$	_	1	1	1	-	Ŀ	C	4_	4	1	_	1	Ļ	1	L	┵	-		4		- -	$\perp$	4
2313	Dispersion Control System Calibrator Composite Materials Sample Evaluator		$\mathbb{R}$	3.4		$\dashv$	+	+	+-		-	1	+	; -	12	-	$\vdash$	1	4	K	╀┦			+		+	+	-
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2316	Immiscible Liquid Sample Remover			Δ				I	I			I		1	18							П		$\Box$	$\Box$		I	Ţ
2317	Immiscible Liquid Sample Installer Slip Casting Translocator			R	4	_	4	1	-	ł į	-	1	+	+	A	<u>_</u>	-	1	4-	-	1-1			+	-	4	+	+
	Slip Casting Translocator Immiscible System Casting Translocator	8.5		H	+	-	+	+	-	100	1	#	+	长	}-	-		+	1	F	+-	H		+	+	+	+	+
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2321	Mixing Equipment Controller			$\frac{1}{2}$	$\Box$	$\perp$	$\perp$	Γ	L	]		Ļ	I		X		L	L	L,	L	Ш		4	4	4	┵	$\perp$	$\perp$
2372	Slip Materials Installer Casting Mold Disassembler		$\vdash$	$\mathbb{R}$	-	+	+	+	╀	-	-	₽	4	+×		-	-	╀	╀	┼-	$\vdash$	Н	-	+	+	╁	+	╁
	Casting Mold Installer	333	Н	7	+	7	2 ×	13	15	ि	+	1	्र		憶		- 10	18		्		12	7	1	71	+	10	+
2325	Liquid Dispersion Research Status Determinen			$\overline{\triangle}$			1		1	1	L	I		I	K					L	П		I	I	I	I	I	I
	Liquid Dispersion Research Monitor			A	-	4	- -	4	Ļ	ि	-	1	4	-	松	-	100	-	-	+	$\sqcup$		+	4	-	+	+	+
	Slip Cast Injection System Control Actuator		$\vdash$		+	-	+	+	+	1	+	+	F	+	1	-		-	-	-	H		+	+	+	+	+	+
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TABLE C-7: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-4 (Small and Low Temperature Experiments).

	TASK - SKILL	YLOADS/EXPERIMENTS	FIL	Crystal Growth/Melts						OCCUPATIONAL SKILLS	General Technical	Electrical Technic	Radio Engineer	Instrumentation Technician	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical	Physicist, Heat	Calibrator	Inspector, Systems	Electronics Mechanic							
		PA	7	-4(2)						CODE	000.000	003.181	3.187	003.281	.281	022.081	022.081	023,081	710.884	722, 281	787							
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0025	TV Camera Translocator			\(\alpha\)							Q			X								7						
0039	Camera Installer TV Camera Unstower		长			4	#	4-	1		H		Н	$\langle \cdot \rangle$	4			4	4	34	4	4	#		4		=	
0079	TV Camera Inspector		庆	7			+	+	+	l	H			44	ी	1				$\overline{\Box}$	X		#		+	H		ا: ا
0206	Radio Communicator	1	$\overline{Z}$	Ñ	Ħ			T	1				$\overline{\circ}$	X	1	ी			ු්				1	و ا	1		أق	
0245	Camera Control Actuator		$\triangle$	Ų			1	I	$\Gamma$	[		П		Ø	I	$\Box$		1				I	I	T	I	口		$\Box$
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0294	Camera Inspector	ll .	兴	쉱	-	$\dashv$	+	+-	┼	1	$\vdash$	$\overline{}$	Н	$\Diamond$	+	-	-	4		익	4	+	+	- -	+-	H	$\dashv$	$\dashv$
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0633	TV Camera Tester		$\nabla$	$\triangle$	$\Box$	$\Box$	I	I				Ō		X			$\Box$	$\Box$			$\Box$	$\Box$	I		L	П	$\Box$	
0661	TV Camera Remover		Ķ	$\Box$	-		4	-	1		-	Q	_	$\stackrel{>}{\bowtie}$	4	4		4	4		4	-}-	+	-	+-	$\vdash$	$\dashv$	_
0662	Telemetry Equipment Control Actuator TV Camera Fault Identifier	1	栚	爿	$\dashv$		+	+	┼	٠.	-	Н		$\Omega$	+		-	+	+	-	7	+		- -	+-	╁┥	-	$\dashv$
0690	TV Camera Repairer		$\overline{\wedge}$	N	+	7	+	十	†		H		-1	-	+	+	-	-	7		ă	十	+	+	+	$\Box$	$\dashv$	-
0847	Computer Control Actuator			囚		1								<b>Ø</b>	Ì	I		1	I	Ĭ	1	工	1				1	
0386	Camera Fault Identifier		$\triangle$		_	$\perp$	I	1_		Ţ,						$\Box$		1	1	_	3	1	1	1			4	_
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0980	Furnace Unstower Furnace Module Remover	1	$\forall$		-		+	+-	$\vdash$		$\vdash$	a	-	∜	+	+	-	ᆉ	+	+	+	+	+	+-	<del> </del> -	$\vdash$	+	ㅓ
0982	Furnace Module Installer	ii	$\overline{}$	-	+	-+	+	十	╁╼		Н	ă	7	⅌	+	+	+	+	+	7	+	+	+	+-	+-	$\vdash$	+	7
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0989	Furnace Fault Identifier  Mixing Unit Installer		$\wedge$	A	+	+		+	-		H	$\exists$	-	$\downarrow$	+	+	+	+	+	+	4	+	+	+-	+-	1	-	-
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0993		I	$\triangle$	$\triangle$			1				$\bigcirc$			X				1				I	I					
0994	Mixing Unit Remover			$\Box$	1	1	1	1			$\bigcirc$	4		싫	4	4	4	4	4	$\dashv$	4	+	+	+	4	H	4	4
0998	Mixing Unit Cleaner			$\triangle$	4		+	+-	$\vdash$		Н			<b>X</b>	+	+	$\dashv$	+	╬	+	+	+	+	╁	+		+	$\dashv$
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1017	Materials Forming Equipment Unstower				4	-	4-	+-	$\vdash$		o		-		+	+	4	4		4	+	+	+	+	-	<del> </del> +	$\dashv$	
1018	Materials Forming Equipment Translocator  Materials Forming Equipment Cleaner	-	K	-	+	<del>.</del>	+	+			M			长	+	+	+	+	+	$\dashv$	+	+	+	+	+		+	-
1046	Materials Analysis Equipment Calibrator		囚	M		7	+	+	H	1			آ خ		1	+	-†	K	5		XT	1	士	I			士	
1048	Materials Analysis Equipment Cleaner	il 🗀			丁	I	1		口					গ্ৰ	1	1	J		$\top$		I	I	I	Ţ		口	I	I
1049	Materials Analysis Equipment Controller		Ц		1	$\perp$	1	1	Ц		Ц	1	4	$\downarrow$		2 2	4	4	4	4	_	4	+	+	1	┰	4	4
1054	Computer Unstower		Н	$\mathbb{R}$	+	+	+-	+-	$\vdash$		Н	$\dashv$	-	X	+	+	+	+	+	+	+	+	十	+	+	$\vdash$	$\dashv$	$\dashv$
1055	Computer Operation Monitor Environmental Chamber Unstower		H	$\forall$	+	+	+	+	+		Н	+		斜	+	+	+	+	+	+	+	+	+	+	+-	$\vdash$	+	ᅱ
1059	Environmental Chamber Unstower Environmental Chamber Module Remover		A	$\overline{\wedge}$	+	+	+	+-	$\forall$		H	O	f	χt	+	+	+	7	_	7	+	士	士	1	1			J
1060	Environmental Chamber Module Installer				1		1	I						X	I	1	I	I	I			I	I	I			I	_]
1062			$\sqrt{\ }$	$^{\prime}$	I	T	L	L	П		Ш	$\downarrow$	_/	图	1	1	4	1	4	4	4	4	+	4-	$\perp$	1	4	4
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1066	Environmental Chamber Fault Identifier	= 3	w vi	11		1	1					- 1	- 1	- 1	- 1	ı										4L		



TABLE C-7: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-4 (Small and Low Temperature Experiments).

(Continued)

	TASK - SKILL	PAYLOADS/EXPERIMENTS	(1) Fluids Convection	Crysta					DCCUPATIONAL SKILLS	General Technical	31 Electrical Technician	Н				1 Physicist Heat	1	├	11 Electronics Mechanic						
CODI			MS-4(1)	MS-4(2)					CODE	000.000	181.181	003.187	3.28	011.281	022.00	023.081	710.834	722.281	8.28						
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1079	Vibrator Installer Vibrator Unstower		17			+		-	-	1	10		$\stackrel{\sim}{\rightarrow}$				ļ.				1			4	
1081	Vibrator Translocator		K					T	10	0			Ż	1						ŽÍS	1	Ħ	Ħ	1	
1632	Vibrator Remover	1	$\wp$	$\Box$	T			1	]	L	$\Omega$		XI.		T	K				1	I		I	T	F
	Vibrator Operation Monitor Vibrator Repairer	i.	长	##		42		+	48	-	12	H	4		48	42		200	Ø.	4	+-	H		+	1
	Vibrator Repairer  Vibrator Fault Identifier				士	T		士	j				+	+	$^{+}$	$\dagger$			ă	_	+	${f H}$	+	+	$\vdash$
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	VHF Power Unit Unstower VHF Power Unit Translocator		-	\	+	+-			-		-	H	<u> </u>	-	-	┼-	-		$\dashv$		+-	╁┼	+	+	╀
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1.025	VHF Power Unit Module Remover		L	Ø					]		Q		X.		1					工	工		工	I	I
	VHF Power Unit Module Installer VHF Power Unit Calibrator		-	$\triangle$	+	+-	-	-	4 🤄	-	9		4		-	-			4	+	+	$\vdash$		+	ļ
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	VHF Power Unit Fault Identifier	1	_	14		44	1	1	]	L			25	1	_	╀			X.	4	$\perp$		_	1	Ļ
1105	Dispersion Control System Unstower Dispersion Control System Cleaner		X	$\vdash$		+	+	╁	-	-	H	$\vdash$		+	╁	╁	$\vdash$	Н	+	+	+	H	+	+	╁╌┘
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111:	Dispersion Control System Repairer	1	$\triangle$		-		$-\Gamma$		]		П		1	T	1	L			X		-			Ţ	L
1114 1127	Dispersion Control System Fault Identifier Atmosphere Supply/Control System Module Remover			$\mathcal{A}$		-		+	4	-		H	$\forall$		4-	-			24	+	+	-	+	+	┨
1128	Atmosphere Supply/Control System Module Installer			囚				+	1		Ŏ		X	+	+				$\top$					+	
1129	Atmosphere Supply/Control System Operation Monitor			A			1	1	]	-					L					1	$\Box$		<b>—</b>	L	$\square$
1132	Atmosphere Supply/Control System Repairer Atmosphere Supply/Control System Fault Identifier		$\vdash$	$\frac{2}{3}$	+-	H	+	╁	-	-	$\vdash$	-	+	-	+	╁	$\left  \cdot \right $	$\vdash$	<del>}</del>	+-	+	╁╌┼	+	+-	⊣
1134				Z	+-	H	+	+	1	-	5	$\vdash$	X	$^{+}$	+	+	H	$\vdash$	4	+	++	1	+	$\dagger$	Н
1135	Power Conditioning/Distribution Sys. Module Installer				$\perp$			$\perp$	]		Ō		X	I		L			$\downarrow$	1	U		工	I	
1136	<u> </u>	١	刽	$\mathbb{A}$	+	Н		$\bot$	4.,	_			쳌.	4-	┦	L		$\Box$		+	$\sqcup$			<del> </del>	$\sqcup$
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1141	Environmental Chamber Operation Monitor: [18] (1)		$\Delta$	$\triangle$	I				1				Ø	I	1					1				I	
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1149	Heat Rejection System Operation Monitor		X		+	12	-+-	+	4°:	-		Н	4	+	+	+		-	7	+	+-1	$\vdash$	+	╁	1
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	Atmosphere Supply/Control System Unstower Power Conditioning/Distribution System Unstower		$^{\prime}$		+	H	-+-	+	-	$\vdash$	Н		8	+	╁	┝	$\vdash$		+	+	╂╌┤	├─┼	+	+	H
1173	Environmental Chamber Control Actuator		$\Delta$	AΕ	士		_		]*					1						工			工	I	
1174	Atmosphere Supply/Control System Control Actuator			4	1	П	I	T	1		Ц		¥	1	$\perp$		Ш	4	4	4	$\sqcup$		-	-	
1175	Furnace Control Actuator Mixing Unit Control Actuator		X	$\forall$	+	┉	+	+	1	$\vdash$	$\vdash$			+	+	-	H	$\dashv$	+	+	╁╌┤	-	+	+-	$\vdash$
1179	Power Conditioning/Distribution Sys, Con. Actuator		囚	团		H	1	+	j.					1						1	口		1	I	
. 1182	Vibrator Control Actuator			Ţ	T	П	I		1		П	$\neg$	ब्र	F	F	F	H	$\Box$	$\bot$	+	$\sqcup$	Ц	1	Į.	$\sqcup$
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TABLE C-7: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-4 (Small and Low Temperature Experiments).

(Continued)

TASK - SKILL	PAYLOADS/EXPERIMENTS	Fluids Convection	Crystal Growth/Melts						OCCUPATIONAL SKILLS	General Technical Skill	Electrical Technician	Radio Engineer	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical	Physicist, Heat	Calibrator	Inspector, Systems	Electrodics Mechanic					
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TABLE C-7: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-4 (Small and Low Temperature Experiments) .

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TABLE C-7: Correlation of Task-Skills with Occupational Skills, Sortle Lab Payload MS-4 (Small and Low Temperature Experiments).

(Continued)

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# DEVELOPMENT OF FLIGHT EXPERIMENT WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

**CONTRACT NAS8-28359** 

FINAL REPORT

APPENDIX G
WORKSTATION CONCEPTS SUPPORTING DATA



#### APPENDIX D

#### TASK DEPENDENCY REFERENCE LIST

#### - NUMERICAL LISTING -

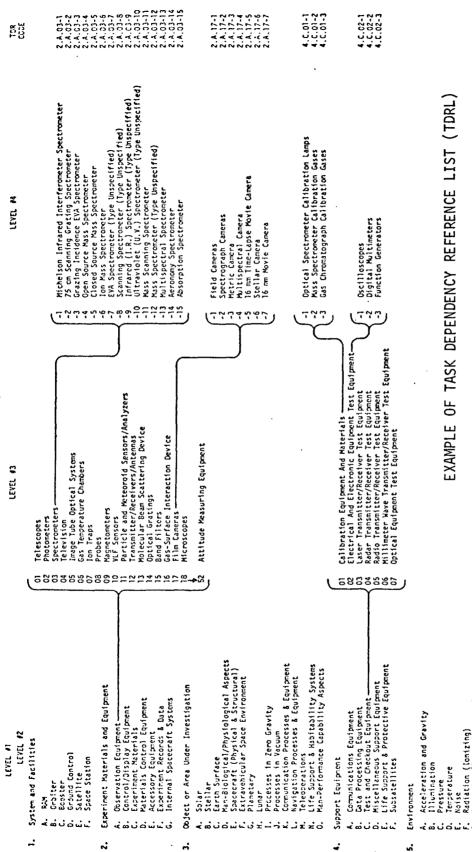
#### EXPLANATION OF TASK DEPENDENCY REFERENCE LIST

During the analysis of crew functions (paragraph 2.2.4), a determination was made of the major types of factors upon which successful task performance depended. These major factors were categorized as:

- 1. System and Facilities
- 2. Experiment Equipment and Materials
- 3. Object or Area Under Investigation
- 4. Support Equipment
- 5. Environment
- 6. Mission Considerations

The six major categories of task dependencies were divided into subcategories based on major functional differences. Then, as each new item of equipment or object of investigation was identified, it was placed in one of the subcategories. Each item was given an alphanumeric code designation to permit ready recognition of the category and subcategory to which it belonged and to promote rapid data retrieval. In addition to these three levels, a fourth level was assigned, where appropriate, to identify specific equipment items, or characteristics. For example, within the major category of "Experiment Equipment" (#2), the second level might be "Observation Equipment" (#2.A), and the third level of dependency could be "Spectrometers" (#2.A.03). The fourth level, then, would be various specific types of spectrometers and each type would be assigned a dash number, e.g. "Ion Mass Spectrometer" (#2.A.03-6). An illustration of the structure and use of the Task Dependency Reference System is shown in the following diagram. The complete Task Dependency Reference List comprises the remainder of this appendix to the report.





D-2

Radiation (Radio Frequency) Extravenicular Environment (8 + C + D ± [F + G])

Earth Atmosphere

Fire and/or Explosion Mazard Intraventular Activity Environment (8 + C + D) Coject/Venicle Relationship

Mission Considerations

Ĝ.

A. Mission Events



# TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

1. SYS	STEM AND FACILITIES
	Research and Application Module (RAM)
1.A.01	RAM Structure
1.A.01-1	Locomotion Aids
1.A.01-2	Passageways
1.A.01-3	Airlock Latches
1.A.01-4	Airlock Cable Feedthroughs
1.A.01-5	Extendible Rail/Boom Instrument Mounting Platforms
1.A.01-6	Stability Aids (Dutch Shoes, etc.)
1.A.01-7	Interior Instrument Mounting Platforms
1.A.01-8	Exterior Surface Instrument Mounting Platforms
1.A.01-9	Extendible Rail/Boom
1.A.01-10	Airlock
1.A.01-11	Airlock Hatch Cover
1.A.01-12	Telescope Chamber
1.A.01-13	Telescope Chamber Hatch
1.A.01-14	Viewing Ports
1.A.01-15	External Surfaces
1.A.01-16	Reaction Control System
1.A.01-17	Airlock Mounting Platforms
1.A.01-18	Interior Surfaces
1 4 00	
1.A.02	RAM System Controls and Displays
1.A.02-1	Airlock Security Displays
1.A.02-2	Airlock Pressure Displays and Controls
1.A.02-3	Airlock Latch Controls (Remote Actuating) and Displays
1.A.02-4	Extendible Rails/Boom Controls
1.A.02-5	Extendible Rails/Boom Status and Position Displays
1.A.02-6	Rail/Boom Instrument Platform Position/Orientation
1 4 00 7	Displays/Controls
1.A.02-7	Telescope Chamber Security Displays
1.A.02-8 1.A.02-9	Telescope Chamber Pressure Displays and Controls
1.A.02-9 1.A.02-10	Telescope Chamber Temperature Displays and Controls
1.A.U2-1U	Telescope Chamber Hatch Controls (Remote Actuating)
1.A.03	RAM Facility Equipment
1.A.03-1	Instrument/Equipment Storage Cabinets
1.A.03-2	Toxic Materials Storage Cabinets
1.A.03-3	Data Storage Cabinets
1.A.03-4	Water Recovery System
1.A.03-5	Waste Management System
1.A.03-6	Cooling System
1.A.03-7	(Not Assigned)
1.A.03-8	Atmosphere Supply and Control System
1.A.03-9	Carbon Dioxide Collection System
-	· · · · · · · · · · · · · · · · · · ·

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## TASK DEPENDENCY REFERENCE LIST

### - NUMERICAL LISTING -

1. SYST	TEM AND FACILITIES (Continued)
1.G <u>S</u>	ortie Lab
1.G.01	Sortie Lab Structure
1.G.01-10	Airlock
1.G.01-11	Airlock Hatch Cover
1.G.01-12	Telescope Chamber
1.G.01-13	Telescope Chamber Hatch
1.G.01-14	Viewing Ports
1.G.01-15	External Surfaces
1.G.01-16	Reaction Control System
1.G.01-17	Airlock Mounting Platforms
1.G.01-18	Interior Surfaces
1.G.02	Sortie Lab Module Controls and Displays
1.G.02-1	Airlock Security Displays
1.G.02-2	Airlock Pressure Displays and Controls
1.G.02-3	Airlock Latch Controls (Remote Actuating) and Displays
1.G.02-4	Extendible Rails/Boom Controls
1.G.02-5	Extendible Rails/Boom Status and Position Displays
1.G.02-6	Rail/Boom Instrument Platform Position/Orientation
	Displays/Controls
1.G.02-7	Telescope Chamber Security Displays
1.G.02-8	Telescope Chamber Pressure Displays and Controls
1.G.02-9	Telescope Chamber Temperature Displays and Controls
1.G.02-10	Telescope Chamber Hatch Controls (Remote Actuating)
1.G.02-11	Mission Status Displays and Controls
1.G.02-11.1	Mission Clock
1.G.02-12	Telemetry Controls and Displays
1.G.02-13	(MS) Accident Control System Controls and Displays
1.G.02-14	(MS) Heat Rejection System Controls and Displays
1.G.03	Sortie Lab Module Facility Equipment
1.G.03-1	Instrument/Equipment Storage Cabinets
1.G.03-2	Toxic Materials Storage Cabinets
1.G.03-3	Data Storage Cabinets
1.G.03-4	Water Recovery System
1.G.03-5	Waste Management System
1.G.03-6	Cooling System
1.G.03-7	(Not Assigned)
1.G.03-8	Atmosphere Supply and Control System
1.G.03-9	Carbon Dioxide Collection System
1.G.03-10	Medical Research Facility/Equipment
1.G.03-11	(Not Assigned)
1.G.03-12	Food Storage, Preparation and Feeding Equipment
	0 1 -1



2.	EXPERIMENT EQUIPMENT AND MATERIALS
2.A	Observation Equipment
2.A.01	Telescopes
2.A.01-1	0.9 M. Narrow Field UV Telescope
2.A.01-2	16 Inch Cassegrain Telescope
2.A.01-3	
2.A.01-4	Special Aiming Telescope (Comm/Nav Acquisition Aid)
2.A.01-5	Observation Telescope (Earth Observations)
Z.R.01-3	observacion refescope (Earth observacions)
2.A.02	Photometers
2.A.02-1	Photometric Instrument Cluster (Single Beam, Large Aperture)
2.A.02-1 2.A.02-2	Spectrophotometer
Z.R.UZ-Z	Spectrophotometer
2.A.03	Spectrometers
2.A.03-1	Michelson Infrared Interferometer Spectrometer
2.A.03-1 2.A.03-2	75 CM Scanning Creating Spectrometer (Physic Posting and
2.A.U3-2	75 CM Scanning Grating Spectrometer (Ebert-Fastie or
0 4 07 7	Zerny-Turner)
2.A.03-3	Grazing Incidence EUV Spectrometer
2.A.03-4	Open Source Mass Spectrometer
2.A.03-5	Closed Source Mass Spectrometer
2.A.03-6	Ion Mass Spectrometer
2.A.03-7	EUV Spectrometer (Type Unspecified)
2.A.03-8	Scanning Spectrometer (Type Unspecified)
2.A.03-9	Infrared (IR) Spectrometer (Type Unspecified)
2.A.03-10	
2.A.03-11	
2.A.03-12	
2.A.03-13	
2.A.03-14	• • • • • • • • • • • • • • • • • • •
2.A.03-15	
2.71.00 10	Absorption Spectrometer
2.A.04	Television Systems
2.A.04-1	
	Image Isocon TV System
2.A.04-2	Multispectral TV System
2.A.04-3	TV Camera, Standard Hi Resolution
2 4 05	Image Tube Ontical Continue
2.A.05	Image Tube Optical Systems
2.A.05-1	Space Image Tube Optical System W/Schmidt Corrector Plate
0.4.04	
2.A.06	Gas Temperature Chambers
2.A.06-1	Neutral Gas Temperature Chambers
2.A.07	Ion Traps
2.A.07-1	Planar Ion Trap
	•
2.A.08	Probes
2.A.08-1	Electrostatic Probe



<del>-</del> •	PERIMENT EQUIPMENT AND MATERIALS (Continued)
2.A <u>9</u>	Observation Equipment (Continued)
2.A.08	Probes
2.A.08-2	Electric Field Probe
2.A.08-3	Electron Probe
2.A.09	Magnetometers
2.A.09-1	Flux Gate Magnetometer
2.A.09-2	Magnetometer Search Coil
2.A.10	VLF Sensors
2.A.10-1	(Undefined - See P-1 and P-2)
2.A.11	Particle and Meteoroid Sensors/Analyzers
2.A.11-1	Aluminum Foil Exposure Device
2.A.11-2	Cluster, Electron and Proton Detectors
2.A.11-3	Thick Aluminum Hinged Recovery Panels
2.A.11-4	Cosmic Dust Analyzer Target Plate Assembly
2.A.11-5	Cosmic Dust Analyzer Ion Collector
2.A.11-6	Optical Meteoroid Detector
2.A.11-7	Small Meteoroid Mass and Velocity Sensor Arrays
2.A.11-8	Thick Material Meteoroid Penetration Device (TMMPD)
2.A.12	Transmitter/Receivers/Antennas
2.A.12-1	Laser Communication Transmitter
2.A.12-2	Laser Communication Receiver
2.A.12-3	Millimeter Wave Antennas and Antenna Feeds (Radio)
2.A.12-4	Millimeter Wave Transmitter (Radio)
2.A.12-5	Millimeter Wave Receiver (Radio)
2.A.12-6	Emergency Location Transmitter (ELT) Transponder (Radio)
2.A.12-7	Interferometer Antenna Array (Radio)
2.A.12-8	VHF Transmitter (Radio)
2.A.12-9	L-Band Transmitter (Radar)
2.A.12-10	VHF Receiver (Radio)
2.A.12-11	L-Band Receiver (Radar)
2.A.12-12	VHF Antennas (Radio)
2.A.12-13	Frequency Synthesizer (Radio)
2.A.12-14	Laser Radar Transmitter
2.A.12-15	Laser Radar Receiver
2.A.12-16 2.A.12-17	Microwave Radar Transmitter
2.A.12-17 2.A.12-18	Microwave Radar Receiver
2.A.12-18 2.A.12-19	X-Band Transmitter (Radar)
2.A.12-19 2.A.12-20	X-Band Receiver (Radar)
2.A.12-21	Narrow Beam Tracking Antenna (Radar)
2.A.12-21 2.A.12-22	Broad Beam Transmitting Antenna (Radar) X-Band Transmitter Antenna (Radar)
2.A.12-23	L-Band Antennas (Radar)
-111,12-23	r-pand Antennas (kadar)



2.	Observation Equipment (Continued)
2.A	Molecular Beam Scattering Devices
2.A.13	Morecular beam scattering bevices
2.A.14	Optical Gratings
	- · · · · · · · · · · · · · · · · · · ·
2.A.14-1	
2.A.14-2	Coarse Optical Gratings
2.A.15	Band Filters
2.A.15-1	
2.A.15-2	Broad Band Filters
2.A.16	Gas-Surface Interaction Device
2.A.16-1	
2.A.16-2	
2.A.16-3	
2.A.10-3	Plating Materials Boats
2.A.17	Film Cameras
2.A.17-1	Field Cameras
2.A.17-2	
2.A.17-3	
2.A.17-3 2.A.17-4	
2.A.17-5	=
2.A.17-6	
2.A.17-7	16 mm Movie Camera
2.A.18	Mignoscopes
2.A.18-1	Microscopes
2.A.10-1	Phase-Contrast Microscope
2.A.19	Scanners
2.A.19-1	Multispectral Scanner
2.A.19-2	Passive Microwave Scanner
2111113 2	russive microwave scanner
2.A.20	Plethysmographs
2.A.20-1	Leg Volume Plethysmograph
21,1120 1	beg volume i lethysmograph
2.A.21	Radiometers
2.A.21-1	Microwave Mapping Radiometers
2.A.21-2	Multispectral Radiometer
	Maretopootial Radiometer
2.A.22	Scatterometers
2.A.22-1	Scatterometer/Radiometer
1	Source Commerce ( Madiometer
2.A.23	Polarimeters
2.A.24	Sferics Detector



2.	EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
2.A	Observation Equipment (Continued)
2.A.25	Refractometers
2.A.25-1	Goldberg Refractometer (AO)
2.A.26	Body Temperature Measurement Devices
2.A.26-1	Thermometers
2.A.26-2	
2.A.26-3	
2.A.27	Film .
2.A.27-1	Metric Camera Film
2.A.27-2	
2.A.27-3	
2.A.27-4	
2.A.27-5	
2.A.27-6	
Z. A. 27-0	Tomm Camera Tim
2.A.28	Spectrographs
2.A.29	Gas Chromatograph
2.A.30	Calorimeter
2.A.30-1	
2.71.30	(Differential Thermal Analyzer)
	(Differential Inclinal Intaly 201)
2.A.31	Contamination Coupons
2.A.32	Body Mass Measurement Device
	•
2.A.33	Blood Test/Measurement Device and Equipment
2.A.34	Food Moisture Measurement Device
2.A.J4	rood moisture measurement pevice
2.A.35	Body Waste Measurement Devices and Equipment
	and Equipment
2.A.36	X-Ray Analysis Equipment
2.A.36-1	
2.A.36-2	
	•
2.A.37	Ergometers
2.A.37-1	Bicycle Ergometer (Skylab M171 Model)
2.A.38	Biological Contamination Sampling Equipment
2.A.38-1	Reynier Plates
2.A.38-2	
2.A.38-3	
2.A.38-4	1.64 1 = 4.15.1
2.A.30-4	Rodac Plates



2. A 2. A . 38 2. A . 38 - 5 2. A . 38 - 6 2. A . 38 - 7	Observation Equipment (Continued)  Biological Contamination Sampling Equipment (Continued)  Gram Staining Equipment  Nutrient Broth  Differential/Selective Media
2.A.39 2.A.39-1 2.A.39-2	Interferometers Holographic Interferometer Schlieren Optical Interferometer
2.A.40 2.A.40-1 2.A.40-2	Densitometers Photometric Densitometer Ultraviolet (UV) Densitometer
2.A.41 2.A.41-1	Biomedical Measurements Instruments EVA/Biomedical Measurements Sensors
2.A.42	Sphygmomanometers
2.A.43	Holographic Devices
2.A.44	High Temperature Viewing Device
2.A.45	Magnetostatic Devices
2.A.46	Optical Monitoring Probes (Type Unspecified)
2.A.47 2.A.47-1	Pressure Monitoring Probes Thermocouple Gauge
2.A.48	Temperature Monitoring Probes
2.A.49	Spacecraft Plasma Monitoring Probes (Type Unspecified)
2.A.50 2.A.50-1 2.A.50-2	Power Monitoring Devices Transmitted Microwave Power Monitor Reflected Microwave Power Monitor
2.A.51	VSWR Measuring Equipment
2.A.52	Attitude Measuring Equipment
2.A.53	Accelerometers
2.A.54	Head Proximity Device



2.	EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
2.A	Observation Equipment (Continued)
2.A.55	Electrocardiographs
2.A.55-1	Vectorcardiographs
2.A.56	Electroanalytical Apparatus
	•
2.A.57	Cardiotachometers



	PERIMENT EQUIPMENT AND MATERIALS (Continued)  Control/Display Equipment  Control/Display Equipment - Astronomy  C/D Console, 0.9 M. Narrow Field UV Telescope  C/D Console, Wide Field UV Telescope  Instrument Power Distribution Controls and Displays  Spectrometer Operating Controls and Displays
2.B.01-5 2.B.01-6 2.B.01-7	Telescope Operation Controls and Displays Telescope Deployment Controls and Displays Automatic Film Changing System Controls and Displays
2.B.02 2.B.02-1 2.B.02-2 2.B.02-3 2.B.02-4 2.B.02-5 2.B.02-6 2.B.02-7 2.B.02-8 2.B.02-9 2.B.02-10 2.B.02-11 2.B.02-12 2.B.02-13 2.B.02-14	Control/Display Equipment - Physics Single Sweep Oscilloscope Controls and Displays Instrument Power Distribution Controls and Displays Spectrometer Operating Controls and Displays Gas-Surface Interaction Controls and Displays Telescope Operation Controls and Displays Telescope Deployment Controls and Displays SITOS Operation Controls and Displays Zero-G Combustion Controls and Displays Chemical Laser Controls and Displays Physics Subsatellite Controls and Displays Electron Probe Controls and Displays Photometer Controls and Displays Gas Reaction Data Acquisition Displays Canister Release Controls
2.B.03 2.B.03-1 2.B.03-2 2.B.03-3 2.B.03-4 2.B.03-5 2.B.03-6 2.B.03-7 2.B.03-8 2.B.03-9 2.B.03-10	Control/Display Equipment - Comm/Nav Laser Communication Control/Display Equipment Subsatellite Control/Display Equipment Millimeter Wave R/T Control/Display Equipment ELT Transponder Control/Display Equipment Satellite Navigation Control/Display Equipment Laser Radar Control/Display Equipment Autonomous Navigation Control/Display Equipment Plasma Propagation Control/Display Equipment Transmitter Breakdown Test Control/Display Equipment Multipath Measurements Control/Display Equipment
2.B.04 2.B.04-1 2.B.04-2 2.B.04-2.1 2.B.04-2.2 2.B.04-2.3 2.B.04-2.4	Control/Display Equipment - Earth Observations Cloud Chamber Controls and Displays Scatterometer-Radiometer Panel Scatterometer On/Off Radiometer On/Off SR Scan Mode Selector (1-8) Filter Selector (1-8)



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2.
         EXEPRIMENT EQUIPMENT AND MATERIALS (Continued)
2.B
           Control/Display Equipment (Continued)
2.B.04
             Control/Display Equipment - Earth Observations (Continued)
2.B.04-2
               Scatterometer-Radiometer Panel (Continued)
2.B.04-2.5
                 Altimeter On/Off
                 RIB/ALT Gage
2.B.04-2.6
                 ALT Range Selector (1-8)
2.B.04-2.7
               Microwave Radiometer Panel
2.B.04-3
2.B.04-3.1
                 Power On/Off
2.B.04-3.2
                 3M Ant. On/Off
2.B.04-3.3
                 9M Ant. On/Off
2.B.04-3.4
                 3M Ant. Band Selector (1-8)
                 9M Ant. Band Selector (1-8)
2.B.04-3.5
2.B.04-3.6
                 Antenna Pointing (3M/9M)
2.B.04-3.7
                 Temperature Gage (0 - 100°C)
                 Ant. Temp. Sens. (3M/9M)
2.B.04-3.8
2.B.04-4
               Passive Microwave Scanner Panel
                 Power On/Off
2.B.04-4.1
2.B.04-4.2
                 Cal. Test/Ctr. Test
2.B.04-4.3
                 Frequency Selector (1-8)
                                                                               7)
2.B.04-4.4
                 MIN Crt. Pwr. On/Off
2.B.04-4.5
                 Brightness Control
                 Crt. Monitor
2.B.04-4.6
                 Focus Control
2.B.04-4.7
2.B.04-5
               Stellar Camera Panel
2.B.04-5.1
                 Stel. Camr. On/Off
2.B.04-5.2
                 Camr. Selector (1-8)
2.B.04-5.3
                 Spectral Range Adj. (1-8)
2.B.04-5.4
                 Stel. Camr. Frame Rate (1-8)
2.B.04-5.5
                 Ready/Operate Indicator Light
2.B.04-5.6
                 Start/Stop
2.B.04-5.7
                 Frames Remaining Counter
2.B.04-6
               Metric Camera Panel
2.B.04-6.1
                 Power On/Off
                 Met. Camr. On/Off
2.B.04-6.2
2.B.04-6.3
                 Spectral Range Adj. (1-8)
2.B.04-6.4
                 Met. Camr. Frame Rate (1-8)
2.B.04-6.5
                  Ready/Operate Indicator Light
2.B.04-6.6
                  Start/Stop
2.B.04-6.7
                  Frames Remaining Counter
2.B.04-7
               Internal Pointing/Alignment Panel
2.B.04-7.1
                 Experiment Align. Selector 1 (1-8)
                 Alignment Controller 1 (Pitch/Yaw)
2.B.04-7.2
                 Experiment Align. Selector 2 (1-8)
2.B.04-7.3
2.B.04-7.4
                 Alignment Controller 2 (Pitch/Yaw)
2.B.04-7.5
                 Monitor 1
2.B.04-7.6
                 Monitor 2
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EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
2.
2.B
           Control/Display Equipment (Continued)
             Control/Display Equipment - Earth Observations (Continued)
2.B.04
2.B.04-8
               Sferics Detector C/D Panel
                  MN Pwr. On/Off
2.B.04-8.1
2.B.04-8.2
                  Frequency Indicator
2.B.04-8.3
                  Amp Gain (1-8)
                  Band Pass Selector (1-8)
2.B.04-8.4
2.B.04-8.5
                  Beam Width Selector (1-8)
               Absorption Spectrometer C/D Panel
2.B.04-9
2.B.04-9.1
                 Power On/Off
2.B.04-9.2
                  Cal. Test/Ctr. Test
2.B.04-9.3
                 WLTH Selector (ST/LG)
2.B.04-9.4
                 ST/LG Indicator Light
2.B.04-9.5
                 Spec. Filt. Selector (1-8)
2.B.04-9.6
                 Data Recorder On/Off
2.B.04-9.7
                 Recorder Drive Selector (PB/Rec)
2.B.04-9.8
                 PB/Rec Indicator Light
2.B.04-9.9
                 Absorption Energy End Counter
               Multispectral Spectrometer C&D Panel
2.B.04-10
2.B.04-10.1
                 Power On/Off
2.B.04-10.2
                 Img. Sys. (ENA/INH)
2.B.04-10.3
                 Spectral Band Selector (1-8)
2.B.04-10.4
                 Temperature Selector
2.B.04-10.5
                 Temperature Gage (-100 to -100°F)
2.B.04-11
               Multispectral Radiometer C/D Panel
2.B.04-11.1
                 Power On/Off
2.B.04-11.2
                 RF Band Selector (1-8)
2.B.04-11.3
                 Search Angle Selector (1-8)
2.B.04-11.4
                 Frames Remaining Counter
2.B.04-11.5
                 Vid. Trk. (ENA/INH)
2.B.04-12
               Multispectral Camera C/D Panel
2.B.04-12.1
                 Camera Power On/Off
2.B.04-12.2
                 Filter Selector (1-8)
2.B.04-12.3
                 Filter Confirm Light
2.B.04-12.4
                 Exposure Time Selector (1-8)
2.B.04-12.5
                 Frame Rate Selector (1-8)
2.B.04-12.6
                 Ready/Operate Light
2.B.04-12.7
                 Start/Stop
2.B.04-12.8
                 Frames Remaining Counter
2.B.04-13
               Multispectral Camera TV C/D Panel
2.B.04-13.1
                 Power On/Off
2.B.04-13.2
                 Record Pwr. On/Off
2.B.04-13.3
                 Slit Focus Adj.
2.B.04-13.4
                 Collim. Adj.
2.B.04-13.5
                 Line Scan Speed Adj. (1-8)
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EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
2.
2.B
           Control/Display Equipment (Continued)
2.B.04
             Control/Display Equipment - Earth Observations (Continued)
               Multispectral Camera TV C/D Panel (Continued)
2.B.04-13
2.B.04-13.6
                 Band Width Selector (1-8)
2.B.04-13.7
                 Vid. Recorder On/Off
                 Vid. Recorder Ft Remaining Counter
2.B.04-13.8
2.B.04-14
               Multispectral Scanner C/D Panel
2.B.04-14.1
                 Power On/Off
2.B.04-14.2
                 Mode Selector (1-8)
2.B.04-14.3
                 Align. Pos. Sel. (1-8)
2.B.04-14.4
                 Cal. Test/Ctr. Test
                 Data Rec'dr On/Off
2.B.04-14.5
2.B.04-14.6
                 Data Store/Erase
2.B.04-14.7
                 Store/Erase Indicator Light
2.B.04-14.8
                 Cal. Source Inten. Counter
2.B.04-14.9
                 Channel Selector (Pri/Sec)
2.B.04-14.10
                 Cryo. Pump (Pri/Sec)
2.B.04-14.11
                 Cryogenic Pressure Gage (0 - 100)/Temp. Gage (-20 to +60)
2.B.04-15
               Microwave Radar C/D Panel
2.B.04-15.1
                 Power On/Off
2.B.04-15.2
                 Ant. Motor Drive On/Off
2.B.04-15.3
                 Ant. Deploy/Retract
2.B.04-15.4
                 Ant. Dir. Sel. (1-8)
                 Data Recv'd (ENA/INH)
2.B.04-15.5
2.B.04-15.6
                 Data Tape Remaining Counter
2.B.04-16
               Spectral Polarimeter C/D Panel
2.B.04-16.1
                 Power On/Off
2.B.04-16.2
                 Tele. Bias. In/Out
                 Camera ENA/INH
2.B.04-16.3
2.B.04-16.4
                 Data Rec'dr On/Off
2.B.04-16.5
                 Recorder Sel. (PB/Rec)
2.B.04-16.6
                 PB/Rec Indicator Light
               Aeronomy Spectrometer C/D Panel
2.B.04-17
2.B.04-17.1
                 Interf. On/Off
2.B.04-17.2
                 Spectrom. On/Off
2.B.04-17.3
                 Cal. Test/Ctr. Test
2.B.04-17.4
                 Tele. Bias In/Out
2.B.04-17.5
                 Data Recdr. On/Off
2.B.04-17.6
                 Rec'dr Sel. (PB/Rec)
2.B.04-17.7
                 PB/Rec Indicator Light
2.B.04-18
               Observation Telescope C/D Panel
2.B.04-18.1
                 Power On/Off
2.B.04-18.2
                 Collin. Act/Deact
2.B.04-18.3
                 Camr. On/Off (DAC)
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EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
2.
2.B
           Control/Display Equipment (Continued)
              Control/Display Equipment - Earth Observations (Continued)
2.B.04
2.B.04-18
                Observation Telescope C/D Panel (Continued)
2.B.04-18.4
                  Frame Rate (Fast/Slow) (DAC)
2.B.04-18.5
                  Tape Rec'dr On/Off
2.B.04-18.6
                  Rec'dr PB/Rec
2.B.04-18.7
                  PB/Rec Light
2.B.04-18.8
                  Frames Remaining Counter (DAC)
             Control/Display Equipment - Life Sciences
2.B.05
2.B.05-1
               Readouts and gages (Undefined)
2.B.05-2
               Heart Rate Monitor
2.B.05-3
               Medical Research Control/Display Console
2.B.05-4
               Life Support Subsystem Test Unit (LSSTU)
               Life Sciences Experiment Support Unit
2.B.05-5
2.B.06
             Control/Display Equipment - Materials Science
2.B.06-1
               Process Control Computer
2.B.06-2
               Instrumentation and Control Center
2.B.06-3
               Biological Enclosure C/D Panel
2.B.06-3.1
                 Pwr On/Off
2.B.06-3.2
                 UV Lamp On/Off
                 UV Lamp Indicator Light
2.B.06-3.3
2.B.06-3.4
                  Shower On/Off
                 Shower Indicator Light
2.B.05-3.5
2.B.06-3.6
                 Start/Stop Switch
2.B.06-3.7
                 Start/Stop Indicator Light
2.B.06-4
               Controlled Atmosphere Chamber C/D Panel
2.B.06-4.1
                 Pwr On/Off
2.B.06-4.2
                 Ion Bomb (On/Off)
2.B.06-4.3
                 Ion Bomb Indicator Light
2.B.06-4.4
                 Ion Pump Set Switch
2.B.06-4.5
                 Ion Pump Indicator Light
2.B.05-4.6
                 Sub Pump Set Switch
2.B.06-4.7
                 Sub Pump Indicator Light
2.B.06-4.8
                 Start/Stop Switch
2.B.06-4.9
                 Start/Stop Indicator Light
2.B.06-5
               General Purpose Lab Installation C/D Panel
2.B.06-5.1
                 Pwr On/Off
2.B.06-5.2
                 Vac Pull On/Off
2.B.06-5.3
                 Power Gage (0 - 100)
2.B.06-5.4
                 Vac Gage (-20 to +60)
2.B.06-5.5
                 Gas #1 On/Off
2.B.06-5.6
                 Gas #1 Supply Status Gage (-100 to +100)
2.B.06-5.7
                 Gas #2 On/Off
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```
EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
2.
2.B
           Control/Display Equipment (Continued)
             Control/Display Equipment - Materials Sciences (Continued)
2.B.06
                General Purpose Lab Installation C/D Panel (Continued)
2.B.06-5
                  Gas #2 Supply Status Gage (-80 to +80)
2.B.06-5.8
2.B.06-5.9
                  Gas #3 On/Off
2.B.06-5.10
                  Gas #3 Supply Status Gage (0 - 100)
                  Gas #4 On/Off
2.B.06-5.11
2.B.06-5.12
                  Gas \#4 Supply Status Gage (-20 to +60)
2.B.06-6
               Environmental Chamber A/B C&D Panel
2.B.06-6.1
                  Chamber Select Switch (A/B)
                  Chamber Select Switch Indicator Light
2.B.06-6.2
                 Temperature Gage (0 - 100°C)
2.B.06-6.3
2.B.06-6.4
                 Start/Stop Switch
2.B.06-6.5
                 Start/Stop Indicator Light
2.B.06-6.6
                 Pwr On/Off
2.B.06-6.7
                 Temperature Control Knob
               Atmosphere Supply and Control System C&D Panel
2.B.06-7
2.B.06-7.1
                 Pwr On/Off
2.B.06-7.2
                 Gas Intake Valve #1 (Open/Close)
                 Gas Intake Valve #1 Indicator Light
2.B.06-7.3
                 Gas Intake Valve #2 (Open/Close)
2.B.06-7.4
2.B.06-7.5
                 Gas Intake Valve #2 Indicator Light
2.B.06-7.6
                 Gas Intake Valve #3 (Open/Close)
2.B.06-7.7
                 Gas Intake Valve #3 Indicator Light
2.B.06-7.8
                 Gas Intake Valve #4 (Open/Close)
2.B.06-7.9
                 Gas Intake Valve #4 Indicator Light
2.B.06-7.10
                 Vac Pull Switch
2.B.06-7.11
                 Vac Pull Indicator Light
2.B.06-7.12
                 Gas Mix Flow Switch (He) (N2)
2.B.06-7.13
                 He Indicator Light
2.B.06-7.14
                 N2 Indicator Light
2.B.06-7.15
                 Temperature Gage (-100 to -100°C)
2.B.06-7.16
                 Start/Stop Switch
2.B.06-7.17
                 Start/Stop Indicator Light
2.B.06-8
               Sensor Selection and Display Panel
2.B.06-8.1
                 Pwr On/Off
2.B.06-8.2
                 Sensor 1 On/Off Switch
2.B.06-8.3
                 Sensor 1 Indicator Light
2.B.06-8.4
                 Sensor 1 Select Switch (1-8)
2.B.06-8.5
                 Sensor 1 Digital Counter
2.B.06-8.6
                 Sensor 2 On/Off Switch
2.B.06-8.7
                 Sensor 2 Indicator Light
2.B.06-8.8
                 Sensor 2 Select Switch (1-8)
2.B.06-8.9
                 Sensor 2 Digital Counter
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2.
         EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
           Control/Display Equipment (Continued)
2.B
             Control/Display Equipment - Materials Sciences (Continued)
2.B.06
2.B.06-8
                Sensor Selection and Display Panel (Continued)
2.B.06-8.10
                 Sensor 3 On/Off Switch
                 Sensor 3 Indicator Light
2.B.06-8.11
2.B.06-8.12
                 Sensor 3 Digital Counter
               Power Conditioning and Distribution/Circuit Breakers C/D Panel
2.B.06-9
2.B.06-9.1
                 Start/Stop Switch
                 Start/Stop Indicator Light
2.B.06-9.2
                 AC/DC Switch
2.B.06-9.3
2.B.06-9.4
                 AC/DC Indicator Light
2.B.06-9.5
                 Battery Digital Counter
                 Select Switch (1-8)
2.B.06-9.6
                 "Undefined Controls"
2.B.06-9.7
               Resistance Heated Furnace C/D Panel
2.B.06-10
2.B.06-10.1
                 On/Off
                 On/Off Indicator Light
2.B.06-10.2
2.B.06-10.3
                 Temperature Control Knob
2.B.06-10.4
                 Temperature Gage (-80 to +80°C)
2.B.06-11
               Heating and Positioning Coils C/D Panel
2.B.06~11.1
                 Pwr On/Off
2.B.06-11.2
                 Start/Stop Switch
                 Start/Stop Indicator Light
2.B.06-11.3
2.B.06~11.4
                 Power Level Control Knob
2.B.06~11.5
                 Power Level Gage (0 - 100)
2.B.06~11.6
                 Cooling Switch (Max/Min)
2.B.06~11.7
                 Cooling Gage (-20 \text{ to } +60)
2.B.06~12
               Dispersion Control System C/D Panel
2.B.06~12.1
                 Pwr On/Off
2.B.06~12.2
                 Start/Stop Switch
2.B.06-12.3
                 Start/Stop Indicator Light
2.B.06~13
               Mixing Unit - Liquid/Liquid, Liquid/Solid C/D Panel
2.B.06-13.1
                 Nozzle Selector (1-8)
2.B.06-13.2
                 Nozzle Select Indicator Lights
2.B.06~13.3
                 Dispersion Selector (1-8)
2.B.06~13.4
                 Dispersion Select Indicator Lights
2.B.06~13.5
                 Pwr On/Off
2.B.06-13.6
                 Vibrator A On/Off
2.B.06-13.7
                 Vibrator B On/Off
2.B.06~13.8
                 Vibrator A Gage (-100 to +100)
2.B.06-13.9
                 Vibrator B Gage (-80 to +80)
2.B.06-13.10
                 Transducer A On/Off
2.B.06-13.11
                 Transducer B On/Off
2.B.06-13.12
                 Transducer A Indicator Light
2.B.06-13.13
                 Transducer B Indicator Light
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2.
         EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
2.B
           Control/Display Equipment (Continued)
2.B.06
             Control/Display Equipment - Materials Sciences (Continued)
               Mixing Unit - Liquid/Liquid, Liquid/Solid C/D Panel
2.B.06-13
2.B.06-13.14
                 Feed A On/Off
                 Feed B On/Off
2.B.06-13.15
2.B.06-13.16
                 Feed A Indicator Light
2.B.06-13.17
                 Feed B Indicator Light
2.B.06-14
               Remove Measuring Device C/D Panel
                 Pwr On/Off
2.B.06-14.1
                 Start/Stop Switch
2.B.06-14.2
2.B.06-14.3
                 Start/Stop Indicator Light
2.B.06-15
               Mixing Unit - Liquid Gas, C/D Panel
2.B.06-15.1
                 Pwr On/Off
2.B.06-15.2
                 Mix Nozzle Selector (1-6)
2.B.06-15.3
                 Mix Nozzle Select Indicator Light
                 Valve Pres. Selector (1-6)
2.B.06-15.4
2.B.06-15.5
                 Valve Pres. Select Indicator Light
2.B.06-15.6
                 Gas Supply Switch (On/Off)
2.B.06-15.7
                 Gas Supply Indicator Light
2.B.06-15.8
                 Liquid Supply Switch (On/Off)
2.B.06-15.9
                 Liquid Supply Indicator Light
2.B.06-15.10
                 Dispersion Selector (1-8)
2.B.06-15.11
                 Dispersion Percent Gage (0 - 100)
2.B.06-15.12
                 Temperature Selector (1-8)
2.B.06-15.13
                 Temperature Gage (-20 to +60°C)
               Vibrator C/D Panel
2.B.06-16
2.B.06-16.1
                 Small Mech. Pwr On/Off
2.B.06-16.2
                 Small Mech. Start/Stop Switch
2.B.06-16.3
                 Small Mech. Start/Stop Indicator Light
2.B.06-16.4
                 Small Variable Freq. Select Pwr On/Off
2.B.06-16.5
                 Small Variable Freq. Select Start/Stop Switch
2.B.06-16.6
                 Small Variable Freq. Select Start/Stop Indicator Light
2.B.06-16.7
                 Small Variable Freq. Selector (1-8)
2.B.06-16.8
                 Small Variable Freq. Select Digital Counter
2.B.06-16.9
                 Ultrasonic Freq. Select Pwr (On/Off)
2.B.06-16.10
                 Ultrasonic Freq. Select Start/Stop Switch
2.B.06-16.11
                 Ultrasonic Freq. Select Start/Stop Indicator Light
2.B.06-16.12
                 Ultrasonic Freq. Selector (1-8)
2.B.06-16.13
                 Ultrasonic Freq. Select Digital Counter
2.B.06-17
               Variable High freq. Power Unit C/D Panel
2.B.06-17.1
                 Pwr On/Off
2.B.06-17.2
                 Frequency Selector (1 - 8)
2.B.06-17.3
                 Frequency Selector Indicator Light
2.B.06-17.4
                 Power Switch (High/Low)
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EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
2.
           Control/Display Equipment (Continued)
2.B
             Control/Display Equipment - Materials Sciences (Continued)
2.B.06
               Variable High Freq. Power Unit C/D Panel (Continued)
2.B.06-17
                 Power Switch Indicator Light
2.B.06-17.5
                 Mode Switch (A/B)
2.B.06-17.6
2.B.06-17.7
                 Mode Switch Indicator Light
2.B.06-17.8
                 Level (1/2)
2.B.06-17.9
                 Level Indicator Light
                 Outlet/Power Gage (-20 to +60)
2.B.06-17.10
2.B.06-18
               Microscope Stage Attachment C/D Panel
2.B.06-18.1
                 Heating (On/Off)
2.B.06-18.2
                 Heating Selector (1 - 6)
2.B.06-18.3
                 Cooling (On/Off)
2.B.06-18.4
                 Cooling Selector (1 - 6)
2.B.06-18.5
                 Temperature Gage (0 - 100°C)
2.B.06-19
               Continuous Electrophoretic Column C/D Panel
2.B.06-20
               Buffer Recovery/Waste Disposal C/D Panel
2.B.06-21
               Gas Elimination/Cooling System C/D Panel
2.B.06-22
               Controlled Atmosphere Fluid Storage C/D Panel
2.B.06-23
               Lyophilization C/D Panel
2.B.06-24
               Czochralski Crystal Puller C/D Panel
2.B.06-25
               Silicate Melt Susceptor C/D Panel
2.B.06-26
               Seed Injector C/D Panel (Hollow Bodies Deployment System C/D Panel)
2.B.06-27
               Atmosphere Analysis unit C/D Panel
2.B.06-28
               High Temperature Viewing Device C/D Panel
2.B.06-29
               High Temperature Calorimeter C/D Panel
2.B.06-30
               Internal Friction Measuring Device C/D Panel
2.B.06-31
               Chill System C/D Panel
               Liquid Sphere Deployment System C/D Panel
2.B.06-32
2.B.06-33
               Slip Cast Injection System C/D Panel
2.B.06-34
               Model Zone Refiner C/D Panel
2.B.06-35
               Zone Melter C/D Panel
2.B.06-36
               Peltier Heater/Holder C/D Panel
2.B.07
             Control/Display Equipment - Technology
2.B.07-1
               Teleoperator Control Station
2.B.08
             Manual Pointing Control Equipment
2.B.09
             Video Display Center - Payload Support
```



	ERIMENT EQUIPMENT AND MATERIALS (Continued) Experiment Materials Maps
2.C.01-1	Topographic Maps of Earth Surface
2.C.02 2.C.02-1 2.C.02-2	Rotational Testing Devices and Associated Equipment Rotating Litter Chair Otolith Test Goggles
2. C. 02-3 2. C. 02-4	Magnetic Pointer ("Rod and Sphere Apparatus") Reference Sphere ("Rod and Sphere Apparatus")
2.C.03 2.C.03-1	Physiological Test Devices Lower Body Negative Pressure (LBNP) Device
2. C. 04 2. C. 04-1 2. C. 04-2 2. C. 04-3	Chemicals and Biologicals PAH (Para-Aminohippuric Acid) ADH Agar Nutrient Culture
2.C.04-4 2.C.04-5 2.C.04-6	Bacterial Colonies (Species Not Defined) Solvents Buffer Solutions
2.C.04-7 2.C.04-8 2.C.04-9 2.C.04-10	Biological Materials (for Electrophoretic Separation and Lyophilization) Biological Reagents Enzymes Dopants for Crystal Growth
2.C.05 2.C.05-1 2.C.05-2 2.C.05-3 2.C.05-4	Body Fluids and Wastes Urine Feces Blood Saliva
2.C.06	Laser Fuels and Oxidizer
2.C.07	Chemical Lasers
2.C.08	Food and Drink for Consumption
2.C.09	Fecal Dye Markers
2.C.10 2.C.10-1 2.C.10-2	Teleoperator Spacecraft Video/Illumination System Communication System



2.	EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
2.C	Experiment Materials (Continued)
2.C.11	Airlock Task Board
2.C.11-1	Thermal Insulation
2.C.11-2	Film Pack
2.C.11-3	Thruster Assembly
2.C.11-4	Satellite Skin Panel
2.C.11-5	Electrical Connector
2.C.11-6	Fuel Transfer Lines
2.C.11-7	Adjustment/Alignment Stops
2.C.11-8	Structural Fasteners
2.C.11-9	Jury Structure
2.C.11-10	· ·
2.C.11-11	
2.0.11 11	ridid valves
2.C.12	Docking Adapter
2.C.13	Spare Parts and Tools
2.C.14	Metal Matrix Composite Materials
2.C.14-1	Fiber-Reinforced Composites
2.C.14-2	Particle-Dispersed Composites
2.C.14-3	Cemented Compacts
2.C.14-4	Controlled Eutectic Structures
2.C.14-5	Controlled Monotectic Structures
2.C.14-6	Metal Foams
2.C.14-0 2.C.14-7	
2.6.14-7	Controlled Density Metals
2.C.15	Maintainable Attitude Control System
2.C.16	Flame Chemistry Fuels (Gases) and Oxidizers
2.C.17	Navigation Code Generator
2.C.18	Precision Clock
2.C.19	Inertial Navigation Sensor
2.C.20	Microwave Breakdown Test Structures
2.C.20-1	Microwave Antenna
2.C.20-2	Microwave Antenna Feed
2.C.21	Microwave Radiation Energy
2.C.22	Reentry Vehicle Probes
	•
2.C.23	Basic Metals



2. 2.C	Experiment Materials (Continued)
2.C.24	Immiscible Liquid Systems
2.C.25	Crystal Growth Materials and Samples
2.C.26	Glass Preparation Materials and Samples
2.C.27	Fluid Materials and Samples
2.C.28	Human Subjects
2.C.29 2.C.29-1 2.C.29-2	Atmosphere Supply and Control Systems Two Gas Control Unit Test Specimen (Type Unspecified) Multigas Mass Spectrometer Sensor and Control
2.C.30	EVA Suits
2.C.31	Biopacks
2.C.32	Manikins
2.C.33	EVA Test Assembly (Contents Unspecified)



2. 2.D 2.D.01 2.D.01-1 2.D.01-2	EXPERIMENT EQUIPMENT AND MATERIALS (Continued)  Materials Control Equipment (Continued)  Gas Release Devices  NH <sub>3</sub> Gas Canister  ICN <sup>16</sup> Gas Canister
2.D.02	Cloud Chamber
2.D.03	Gas Storage Devices
2.D.04	Gas Mixing Devices
2.D.05 2.D.05-1 2.D.05-2 2.D.05-3	Ampoule
2.D.06 2.D.06-1	Zero-G Combustion Device Various Size Gas Tubes
2.D.07	Laser Fuel and Oxidizer Containers
2.D.08	Food and Beverage Measuring Equipment
2.D.09	Canister Deployment Mechanisms
2.D.10 2.D.10-1 2.D.10-2	Biological Samples Containers Sample Storage Containers Centrifuge Tubes
2.D.11	Teleoperator Deployment/Retrieval Mechanism
2.D.12	Incubators
2.D.13 2.D.13-1 2.D.13-2 2.D.13-3 2.D.13-4	Environmental Chambers Environmental Chamber "A" - Passive Cooling Environmental Chamber "B" - Passive Cooling Environmental Chamber "C" - Active Cooling Controlled Atmosphere Chamber
2.D.14	Liquid Metal Supply System
2.D.15	Atmosphere Supply and Control System (For Environmental Chambers)
2.D.16	Subsatellite Storage Point/Container



2. I 2.D 2.D.17	EXPERIMENT EQUIPMENT AND MATERIALS (Continued) <u>Materials Control Equipment</u> (Continued)  Mold Injection System
2.D.18	Dispersion Control System
2.D.19 2.D.19-1 2.D.19-2 2.D.19-3 2.D.19-4	Materials Forming Equipment Molds Cavities Crucibles Crystal Growth Tubes
2.D.20	Miscellaneous Internal Attachments (Materials Science)
2. D. 21 2. D. 21-1 2. D. 21-2 2. D. 21-3 2. D. 21-4	Mixing Units Liquid/Solid Mising Unit Liquid/Liquid Mixing Unit Liquid/Gas Mixing Unit Manual Mixing Equipment
2.D.22	Vibrator
2.D.23	Freezers
2.D.24 2.D.24-1 2.D.24-2 2.D.24-3	Furnaces Resistance Heated Furnace (1600°C) Inert/Vacuum Furnace (2600°C) Oxygen Furnace (3200°C)
2.D.25	Open Materials and Fluid Storage Containers
2.D.26 2.D.26-1 2.D.26-2	Water Recovery System/Components Specimen Unit Chemical/Microbial Analysis Equipment
2. D. 27 2. D. 27-1 2. D. 27-2 2. D. 27-3 2. D. 27-4 2. D. 27-5 2. D. 27-6 2. D. 27-7	Materials Analysis Equipment Metallographs Cutoff Saws Polishers X-Ray Diffraction Unit pH Meter Volumetric Displacement Apparatus Zero-G Balance



	ERIMENT EQUIPMENT AND MATERIALS (Continued) aterials Control Equipment (Continued)
2.D.28	Biomedical Fluid Transfer Equipment
2.D.29	Zone Melter
2.D.30	Chemical Storage and Release Devices
2.D.31	Clinical Centrifuges
2.D.32	Heating and Positioning Coil Sets
2.D.33	Plasma Electron Beam Unit
2.D.34	Continuous Atmosphere Analysis Apparatus
2.D.35	Controlled Atmosphere Fluids Storage Equipment
2.D.36	Biological Enclosure
2.D.37 2.D.37-1 2.D.37-2	Electrophoretic Columns Stationary Electrophoretic Column Continuous Electrophoretic Column
2.D.38	Lower Body Negative Pressure (LBNP) Device
2.D.39	Buffer Recovery/Waste Disposal System
2.D.40	Gas Elimination/Cooling System
2.D.41	Food Preparation/Storage/Feeding Equipment
2.D.42	(Not Assigned)
2.D.43 2.D.43-1 2.D.43-2 2.D.43-3 2.D.43-4 2.D.43-5	Lyophilization Apparatus Basic Lyophilization Unit Rack for Sample Vials Sample Vials Heat Pumps Sample Vial Stoppers (Mechanically Actuated)
2.D.44	Biologicals Measuring Device
2.D.45	Susceptor for Silicate Melts
2.D.46	Liquid Sphere Deployment System



2. 2.D	EXPERIMENT EQUIPMENT AND MATERIALS (Continued)  Materials Control Equipment (Continued)
2.D.47	Hollow Bodies Deployment System
2.D.48	Membrane Drawing Tool
2.D.49	Czochralski Crystal Puller
2.D.50	Slip Cast Injection System
2.D.51	Model Zone Refiner
2.D.52	VHF Power Unit
2.D.53	Chill System
2.D.54	Microwave Transmitter, 10 kw
2.D.55	Waveform Modulators
2.D.56	Microscope Stage Heating/Cooling Device
2.D.57	Floating Zone Test Cell
2.D.58	Chemicals and Biologicals Transfer Equipment
2.D.59	Peltier Heater/Holder Device
2.E 2.E.01	Accessories Cables and Connectors
2.E.02	Star Trackers
2.E.02-1 2.E.02-2	
2.E.02-3	Star Field Lock on Unit
2.E.03	Microscopes
2.E.04	Electrodes, Biological Data
2.E.05	Experiment Equipment Drives
2.E.05-1 2.E.05-2	Roll Drive
~.L.UJ-Z	Pitch Drive



2.	EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
2.E	Accessories (Continued)
2.E.05	Experiment Equipment Drives (Continued)
2.E.05-3	Yaw Drive
2.E.05-4	Camera Mirror Cell and Focus Drive
2.E.05-5	Secondary Mirror Cell and Focus Drive
2.E.05-6	Collating Mirror Cell and Focus Drive
2.E.05-7	Fine Grating Drive
2.E.05-8	Coarse Grating Drive
2.E.05-9	Light Shade Drive
2.E.05-10	Filter Slide Drive
2.E.06	Automatic Film Cassette Replacement System
2.E.07	Battery Charger System
2.E.08	Refueling System
2.E.09	X-Ray Shielded Holding Unit
2 E 10	Timing Davises
2.E.10	
2.E.10-1	•
2.E.10-2	Electric/Electronic Timer

2.F.01 2.F.01-1	Experiment Records and Data Film Records Earth Survey Film Data
2.F.02 2.F.02-1 2.F.02-2 2.F.02-3 2.F.02-4 2.F.02-5	Hard Copy Records Questionnaires (Record Keeping Materials) Response Matrix Forms (Record Keeping Materials) Instrument Mode Records Photographs Strip Charts
2.F.03 2.F.03-1 2.F.03-2 2.F.03-3	Tape Recordings Audio Recordings Video Recordings Digital Recordings
2.F.04	Specimen and Samples



2.	EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
2.G	Integral Spacecraft Systems
2.G.01	RAM Mobility Unit
2.G.01-1	Portable Metabolic Rate Analyzer (PMA)
2.G.01-2	
2.G.01-3	
2.G.01-4	
2.G.01-5	
2.G.02	RAM Airlock/EVA Capability Unit
2.G.02-1	Airlocks
2.G.02-2	Pressure Suits
2.G.02-3	EVA Viewing Ports
2.G.02-4	
2.G.02-5	Unspecified Communications Systems
2.G.03	RAM Visual Records Unit
2.G.03-1	Motion Picture Equipment
2.G.03-2	
2.G.04	Reaction Control System
2.G.04-1	Control Valve
2.G.05	Waste Management System



3.	OBJECT OR	AREA	UNDER	INVESTIGATION
3.A	Solar P	henom	ena_	

3.B	Stellar Phenomena
3.B.01	Ultraviolet (UV) Emissions
3.B.01-1	Galaxies
3.B.01-2	Stellar Nebulae
3.B.01-3	Planetary Nebulae
3.B.01-4	Star Clusters
3.B.01-5	Quasars
3.B.01-6	Novae

3.C	Earth Surface
3.C.01	Topography
3.C.02	Near-Earth Atmosphere
3.C.02-1	(Not Used)
3.C.03-2	Air Pollution
3.C.03	Inland Waterways
3.C.03-1	(Not Used)
3.C.03-2	Water Pollution
3.C.04	Oceans
3.C.04-1	Marine Vegetation
3.C.04-2	Water Pollution
3.C.05 3.C.05-1 3.C.05-2 3.C.05-3 3.C.05-4 3.C.05-5	Potential Disasters Geological Precursors Meteorological Precursors Artificial Precursors Topographical Precursors Destructive Events as Precursors
3. C. 06 3. C. 06-1 3. C. 06-2 3. C. 06-3 3. C. 06-4 3. C. 06-5	Actual Disasters Earthquakes Hurricanes Tornadoes Tidal Waves (Tsunamis) Floods



3.	OBJECT OR AREA UNDER INVESTIGATION (Continued)	
3.C	Earth Surface (Continued)	
3.C.06	Actual Disasters (Continued)	
3.C.06-6	Volcanic Eruptions	
3.C.06-7	Forest Fires	
3.C.06-8	Range/Grass Fires	
3.C.06-9	Landslides (Avalanche)	
3.C.06-10	Snowslides (Avalanche)	
3.C.06-11	Land Subsidence	
3.C.06-12	Drought	
3.C.06-13	Blizzards	
3.C.07		

3.D. 3.D.01	Man - Biological and Physiological Aspects Mineral Balance
3.D.02 3.D.02-1 3.D.02-2 3.D.02-3	Rotational Gravity Effects Semicircular Canals Stimulation Threshold Semicircular Canals Stimulation Susceptibility Symptoms Spatial Localization
3.D.03 3.D.03-1	Cardioangiology Cardiovascular Deconditioning
3.D.04 3.D.04-1	Urology Renal Blood Flow
3.D.05	Vestibular Function
3.D.06	Bone Densitometry
3.D.07	Metabolic Activity
3.D.08	Endocrine Function
3.D.09	Exercise Conditioning
3.D.10	Airborne and Surface Contamination
3.D.11	Man's Immunity, in Vitro Aspects
3.D.12	Bacteriology



3. 3.E	OBJECT OR AREA UNDER INVESTIGATION (Continued) Spacecraft (Physical and Structural Factors)
3.F 3.F.01	Extravehicular Space Environment Molecular Beam Scattering
3.F.02	Gas-Surface Interaction
3.F.03	Gas Reactions
3.G	Planetary Studies
3.H	Lunar Studies
3.I 3.I.01	Processes in Zero Gravity Cloud Formation
3.I.02 3.I.02-1 3.I.02-2 3.I.02-3 3.I.02-4	Combustion Phenomena Temperature Pressure Chemical Composition of Flame Flame Visible Structure
3.1.03	Chemical Laser Operation
3.I.04 3.I.04-1 3.I.04-2 3.I.04-3 3.I.04-4 3.I.04-5 3.I.04-6 3.I.04-7	Metal Structure Fiber Orientation Particle Distribution Grain Structure Liquid-Phase Sintering Directional Freezing Monotectic Alloy Mixtures Gas Bubble Distribution (Metal Foams and Controlled Density)



3. I OI 3. I O4 - 8 3. I . 04 - 9 3. I . 04 - 10	BJECT OR AREA UNDER INVESTIGATION (Continued)  Processes in Zero Gravity (Continued)  Metal Structure (Continued)  Free-Casting  Liquid Dispersions; Slip Casting  Liquid Dispersions; Immiscible Liquids
3.I.05 3.I.05-1 3.I.05-2 3.I.05-3 3.I.05-4	Crystal Structure Growth from Solution Growth from Melts Growth from Vapor Homogeneous Nucleation by Supercooling
3.I.06 3.I.06-1 3.I.06-2	Preparation of Glasses Optical Glasses Oxide Composition Glasses
3.I.07 3.I.07-1	Biological Processing Electrophoretic Separation of Organic Molecules
3.1.08	Convection of Fluids
3.J 3.J.01	Process in Vacuum Lyophilization
3.K 3.K.01 3.K.01-1 3.K.01-2	Communication Processes and Equipment Laser Communication Intervehicular Space Communication Space to Ground Communication
3.K.02 3.K.02-1 3.K.02-2	Millimeter Wave Sources Intervehicular Space Communication Space to Ground Communication
3.K.03	Surveillance and Search and Rescue
3.K.04	Laser Radar
3.K.05	Microwave Energy Transmitter Breakdown



3. 3.L	OBJECT OR AREA UNDER INVESTIGATION (Continued)  Navigational Processes and Equipment  Navigation Data
3.L.01	Navigation Data
3.N 3.N.01	Life Support and Habitability Systems and Equipment Water Recovery Methods and Components
3.N.02	Waste Management Methods and Components
3.N.03	Advanced Cooling System Methods and Components
3.N.04	Zero-Gravity Whole-Body Shower
3.N.05	Advanced Two-Gas Atmosphere Supply and Control Systems
3.N.06	Carbon Dioxide Collection Methods and Components
3.N.07	Protective Clothing and Advanced Space Suit Assemblies
3.N.08	EVA Suit and Biopack
3.N.09	Food Storage, Preparation and Feeding Methods
3.N.10	Biopack Technology
3.0 3.0.01	Man - Performance Capability Aspects (Not Assigned)
3.0.02	Cargo Handling Capabilities
3.0.03	Assembly, Deployment, Maintenance and Repair Capabilities
3.0.04	Locomotion and Restraint Capabilities



4. 4.A 4.A.01	SUPPORT EQUIPMENT  Communications Equipment  Telemetry
4.A.02	Voice Radio
4.A.03	Vehicle Intercomm
4.A.04	Data Compression (Dump) Equipment
4.A.05	Data Storage Equipment
4.A.06	EVA-Vehicle Intercom Equipment
4.B	Data Processing Equipment
4.B.01 4.B.01-1	Computers Special Purpose Computer, 0.9 M. Narrow Field UV Telescope
4.B.01-2 4.B.01-3	Experiment General Purpose Computer Telescope Computer (Earth Observations)
4.B.02 4.B.02-1 4.B.02-2	Amplifiers Preamplifiers Narrow Pass Band Amplifiers
4.B.03	Phase Shifter
4.B.04	Phase Sensitive Detector
4.B.05	A/D Converter
4.B.06	Null Signal System
4.B.07	Data Encoding Keyboards
4.B.08	Film Developing Processing Equipment
4.B.09	Data Management Unit, Life Sciences FPEs
4.B.10	Line Readers/Scanners



4. 4.C 4.C.01 4.C.01-1 4.C.01-2 4.C.01-3	Mass Spectrometer Calibration Gases
4.C.02 4.C.02-1 4.C.02-2 4.C.02-3	Digital Multimeters
4.C.03	Laser Transmitter/Receiver Test Equipment
4.C.04	Radar Transmitter/Receiver Test Equipment
4.C.05	Radio Transmitter/Receiver Test Equipment
4.C.06	Millimeter Wave Transmitter/Receiver Test Equipment
4.C.07	Optical Equipment Test Equipment

4.D	Miscellaneous Equipment and Materials
4.D.01	Equipment Covers and Caps
4.D.01-1	Protective Cover, 0.9 M. Narrow Field UV Telescope
4.D.01-2	Protective Cap, 0.9 M. Narrow Field UV Telescope Optics
4.D.01-3	Protective Cover, 16 Inch Cassegrain Telescope
4.D.01-4	Protective Cap, 16 Inch Cassegrain Telescope Optics
40D.01-5	Protective Cap, Star Tracker
4.D.01-6	Protective Cap, Field TV Camera
4.D.01-7	
4.D.01-8	
4.D.01-9	Protective Cap, Radiometer
4.D.01-10	Protective Cap, Scatterometer
4.D.01-11	Protective Cap, Spectrometer
4.D.01-12	Protective Cap, Polarimeter
4 0 00	
4.D.02	Equipment Launch Restraints and Securing Devices
4.D.02-1	Launch Restraints, 0.9 M. Narrow Field UV Telescope
4.D.02-2	Launch Restraints, 16 Inch Cassegrain Telescope



4. SUI	PPORT EQUIPMENT (Continued)
4.D N	Miscellaneous Equipment and Materials (Continued)
4.D.03	Undefined Support Equipment
4.D.03-1	Workspace Equipment and Materials, 0.9 M. Narrow Field UV
	Telescope Experiments
4.D.03-2	Workspace Equipment and Materials, Wide Field UV
	Telescope Experiments
4.D.04	Cameras, Photographic and Film/Accessories
4.D.04-1	Film Cartridge
4.D.04-2	Trace Recording Camera
4.D.04-3	Photographic Camera
4.D.04-4	Visible Cine-Photographic Camera
4.D.04-5	Camera Timer, Programmable
4.D.04-6	Photograph Prints
4.D.04-7	Polaroid Camera
4.D.04-8	Roll Film Camera, 35 mm
4.D.04-9	Movie Camera, 35 mm
4.D.04-10	Plate Film Camera
4 5 05	Danas danas mana
4.D.05	Recorders, Tape
4.D.05-1 4.D.05-2	Voice Recorder, Tape
4.0.05-2	Tape Cartridges and Reels
4.D.06	Cleaning/Decontamination Equipment/Materials
4.D.06-1	Disinfectant
4 5 0=	
4.D.07	Cameras, Electronic
4.D.07-1	S.E.C. Vidicon
4.D.07-2	Combined Electronic/Backup Film Camera
4.D.07-3	Television Camera
4.D.07-4	Video Camera, Commercial Color
4.D.07-5	Video Camera, Standard Black and White
4.D.08	Manual Recording Equipment and Supplies
4.D.08-1	Writing Instruments (Pens, Pencils, etc.)
4.D.08-2	Writing Materials (Paper, Log Books, etc.)
4 D 00	
4.D.09	Inspection Aids
4.D.09-1	Microscopes
4.D.10	Data Recorders, Type Unspecified
	, .,r
4.D.11	Freeze/Vacuum Drying Equipment



4.	SUPPORT EQUIPMENT (Continued)
4.D 4.D.12	Miscellaneous Equipment and Materials (Continued)  Vacuum Pumps
4.D.13	Power Conditioning and Distribution System
4.D.14	Heat Rejection System
4.D.15	Materials Analysis Equipment
4.D.16	Open Materials
4.D.17	Photographic/Film Processing Equipment (See also 4.B.08)
4.D.18	Tools, General Purpose
4.D.19	Freezing/Refrigeration Equipment
4.D.20	Stowage Containers (for Experiment Equipment and Materials)
4.D.21	Portable Lamps
4.D.22 4.D.22-1	Laboratory Benches General Purpose Laboratory Installation (MS)
4.E.01	Life Support and Protective Equipment  Toxic Materials Protection Equipment
4.E.02 4.E.02-1 4.E.02-2 4.E.02-3	(Not Assigned)
4.E.03 4.E.03-1	Eye Protection Equipment Laser Protection Eyeglasses
4.E.04 4.E.04-1	Fire Detection and Control Equipment Accident Control System (Materials Sciences)
4.E.05	Integrated Spacecraft Water Supply System
4.E.06	Integrated Spacecraft Oxygen Supply System



4.F.03

### TASK DEPENDENCY REFERENCE LIST

## - NUMERICAL LISTING -

4. 4.E 4.E.07 4.E.08	SUPPORT EQUIPMENT (Continued)  Life Support and Protective Equipment (Continued)  Integrated Spacecraft Waste Management System  Integrated Spacecraft Advanced Cooling System
4.E.09	(Not Assigned)
4.E.10 4.E.10-1	Personnel Clothing, Garments and Accessories Constant Wear Garment
4.E.11	Tether and Control Unit (for EVA)
4.F. 01 4.F. 01-1 4.F. 01-2 4.F. 01-3 4.F. 01-4 4.F. 01-5 4.F. 01-6	Subsatellites Comm/Nav Subsatellites Satellite Navigation Subsatellite Laser Communication Subsatellite Surveillance/Search and Rescue Subsatellite Laser Ranging Subsatellite Plasma Propagation Subsatellite Multipath Measurements Subsatellite
4.F.02	Physics Subsatellites

Teleoperator Task Board Subsatellite



5.	ENVIRONMENT
5.A	Acceleration and Gravity
5.A.01	Zero-G
5.A.01-1	$< 10^{-4} G$
5.A.02	One-G
5.A.03	Artificial-G (Except Rotational)
5.A.04	Rotational-G
5.B	Illumination
5.B.01	Artificial Illumination
5.B.02	Solar Illumination
5.B.03	Stellar Illumination
	•
5.C	Pressure
5.C.01 5.C.02	Atmospheric Pressure Atmospheric Composition
5.D	Temperature
F.F.	
5.E	Noise
5.F	Radiation (Ionizing)



5. 5.G	ENVIRONMENT (Continued) Radiation (Radio Frequency)
5.Н	<pre>Extravehicular Environment (Includes 5.B + 5.C + 5.D; may include 5.F and/or 5.G</pre>
5.I 5.I.01	Earth Atmosphere  Meteorological Conditions
5.J 5.J.01	Fire and/or Explosion Hazard Combustible Gas Mixtures
5.K	<pre>Intravehicular Environment (5.B + 5.C + 5.D)</pre>
5.L 5.L.01	Object/Vehicle Relationship Relative Velocity
5.L.02	Data-Taking Time
5.L.03	Distance
5.L.04	Relative Position



# TASK DEPENDENCY REFERENCE LIST

# - NUMERICAL LISTING -

6.	MISSION CONSIDERATIONS
6.A	Mission Events
6.A.01	Mission Time
6.A.01-1	Total Mission Time Schedule
6.A.01-2	Elapsed Time
6.A.01-3	Projected Time
6.A.01-4	Actual Time
6.A.02	Mission Schedule

# WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

CONTRACT NAS8-28359

FINAL REPORT

APPENDIX E
FLIGHT EXPERIMENT TASK-SKILL LIST





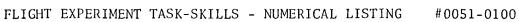
#### APPENDIX E

# FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING EXPLANATION OF TASK-SKILLS

The approach developed to accomplish skill determination was to convert the brief task statement, or applicable portion thereof, into a task-skill title. A task~skill title is a brief phrase which denotes a specific equipment- or procedure-oriented crew function. The task-skill is derived from the primary task dependency and the primary crew function, within the context of the experiment and the task. Some task statements have but one associated task-skill; others, because of the level of complexity or generality of the task statement, have generated two or more task-skill titles. Each task-skill was given a 4-digit code number to avoid duplication in the task-skill processing. 2,044 task-skills were identified across the forty-eight (48) experiments subjected to detailed analysis in the original study. An additional 293 task-skills were identified in the experiments analyzed in the current study, for a total of 2,337. A complete listing, in numerical order, of the identified task-skill titles is included on the following pages of this appendix. Those task-skills which were identified in the current study, and which have been related to Primary Occupational Skills, are preceded by an asterisk (e.g., \*0079 TV Camera Inspector). The correlation between Task-Skills and Occupational Skills may be found in Section 3.0 of this report. Task/Skill Requirements data sheets for each of the experiments, identifying basic functions, task statements, crew functions, operating environments, dependencies, and the associated task-skills and occupational skills, are compiled into a separate volume of the report, Appendix H. A more thorough explanation of the Task-Skill concept may be found in Section 2.0 of the Technical Report.



### Telescope Inspector ### Telescope Cover Remover ### 1002 Telescope Cover Remover ### 1003 Launch Restraint Remover ### 1004 Telescope Optics Cleaner ### 1005 SITOS Optics Cleaner ### 10006 Spectrometer Installer ### 10007 Spectrometer Unstower ### 10008 Spectrometer Translocator ### 10009 Airlock Status Monitor ### 10010 Airlock Inside Hatch Opener ### 10011 Magnetometer Remover ### 10012 VLF Sensor Remover ### 10013 Probe Remover ### 10014 Ion Trap Remover ### 10015 Probe Gas Distribution Monitor ### 10016 Particle Sensor Remover ### 10017 Particle Sensor Remover ### 10019 Gas Temperature Chamber Remover ### 10019 Gas Temperature Chamber Remover ### 10020 Magnetometer Translocator ### 10021 VLF Sensor Translocator ### 10022 Magnetometer Translocator ### 10023 Probe Translocator ### 10024 Ion Trap Translocator ### 10025 Gas Temperature Chamber Translocator ### 10026 TV Camera Translocator ### 10027 Photometer Translocator ### 10026 TV Camera Translocator ### 10027 Spectrometer Cable Selector ### 10027 Spectrometer Cable Router ### 10030 Spectrometer Cable Router ### 10030 Spectrometer Cable Connector ### 10031 Airlock Inside Hatch Closer ### 10032 Airlock Depressurization Actuator ### 10033 Airlock Outside Hatch Opener ### 10034 Rail/Boom Extension Actuator ### 10035 Instrument Power Actuator ### 10036 Spectrometer Control Actuator ### 10037 Spectrometer Control Actuator ### 10038 Spectrometer Fault Identifier ### 10040 Spectrometer Tester ### 10041 Gas Temperature Chamber Assembler ### 10042 Gas Temperature Chamber Installer ### 10043 Spectrometer Grating Installer ### 10044 Spectrometer Grating Remover ### 10045 Spectrometer Grating Remover ### 10046 Spectrometer Grating Installer ### 10047 Oscilloscope Repairer ### 10048 Oscilloscope Repairer ### 10049 Ion Trap Installer ### 10049 Ion Trap Installer ### 10049 Ion Trap Installer ### 10049 Ion Trap Installer ### 10049 Ion Trap Installer		
***Noto ***Launch Restraint Remover***Noto ***Noto ***Launch Restraint Remover***Noto ***Noto ***Launch Restraint Remover***Noto ***Noto ***Launch Restraint Remover** Noto **Noto ***Launch Restraint Remover** Noto **Noto ***Launch Remover** Noto **Noto **Noto ***Launch Remover** Noto **Noto **Noto **Noto ***Launch Remover** Noto **Noto	*0001	Telescope Inspector
*0004 Telescope Optics Cleaner 0005 SITOS Optics Cleaner 0006 Spectrometer Installer 0007 Spectrometer Unstower 0008 Spectrometer Translocator 0009 Airlock Status Monitor 0010 Airlock Inside Hatch Opener 0011 Magnetometer Remover 0012 VLF Sensor Remover 0013 Probe Remover 0014 Ion Trap Remover 0015 Probe Gas Distribution Monitor 0016 Particle Sensor Repairer 0017 Particle Sensor Remover 0018 VLF Sensor Repairer 0019 Gas Temperature Chamber Remover 0020 Particle Sensor Translocator 0021 VLF Sensor Translocator 0022 Magnetometer Translocator 0023 Probe Translocator 0024 Ion Trap Translocator 0025 Gas Temperature Chamber Translocator 0026 TV Camera Translocator 0027 Photometer Translocator 0028 Spectrometer Cable Selector 0029 Spectrometer Cable Connector 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator *0036 Spectrometer Control Actuator 0037 Spectrometer Control Actuator 0038 Spectrometer Fault Identifier 0039 Camera Installer *0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Remover 0045 Film Cartridge Remover 0046 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier	0002	
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0006 Spectrometer Installer 0007 Spectrometer Unstower 0008 Spectrometer Translocator 0009 Airlock Status Monitor 0010 Airlock Inside Hatch Opener 0011 Magnetometer Remover 0012 VLF Sensor Remover 0013 Probe Remover 0014 Ion Trap Remover 0015 Probe Gas Distribution Monitor 0016 Particle Sensor Repairer 0017 Particle Sensor Remover 0018 VLF Sensor Repairer 0019 Gas Temperature Chamber Remover 0020 Particle Sensor Translocator 0021 VLF Sensor Translocator 0022 Magnetometer Translocator 0023 Probe Translocator 0024 Ion Trap Translocator 0025 Gas Temperature Chamber Translocator 0026 TV Camera Translocator 0027 Photometer Translocator 0028 Spectrometer Cable Selector 0029 Spectrometer Cable Router 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator 0036 Spectrometer Control Actuator 0037 Spectrometer Fault Identifier 0038 Spectrometer Tester 0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover 0046 Film Cartridge Remover 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier	<b>*</b> 0004	
0006 Spectrometer Installer 0007 Spectrometer Unstower 0008 Spectrometer Translocator 0009 Airlock Status Monitor 0010 Airlock Inside Hatch Opener 0011 Magnetometer Remover 0012 VLF Sensor Remover 0013 Probe Remover 0014 Ion Trap Remover 0015 Probe Gas Distribution Monitor 0016 Particle Sensor Repairer 0017 Particle Sensor Remover 0018 VLF Sensor Repairer 0019 Gas Temperature Chamber Remover 0020 Particle Sensor Translocator 0021 VLF Sensor Translocator 0022 Magnetometer Translocator 0023 Probe Translocator 0024 Ion Trap Translocator 0025 Gas Temperature Chamber Translocator 0026 TV Camera Translocator 0027 Photometer Translocator 0028 Spectrometer Cable Selector 0029 Spectrometer Cable Router 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator 0036 Spectrometer Control Actuator 0037 Spectrometer Fault Identifier 0038 Spectrometer Tester 0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover 0046 Film Cartridge Remover 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier	0005	SITOS Optics Cleaner
O008 Airlock Status Monitor O010 Airlock Inside Hatch Opener O011 Magnetometer Remover O012 VLF Sensor Remover O013 Probe Remover O014 Ion Trap Remover O015 Probe Gas Distribution Monitor O016 Particle Sensor Remover O017 Particle Sensor Remover O018 VLF Sensor Repairer O019 Gas Temperature Chamber Remover O020 Particle Sensor Translocator O021 VLF Sensor Translocator O022 Magnetometer Translocator O023 Probe Translocator O024 Ion Trap Translocator O025 Gas Temperature Chamber Translocator O026 TV Camera Translocator O027 Photometer Translocator O028 Spectrometer Cable Selector O029 Spectrometer Cable Router O030 Spectrometer Cable Router O030 Spectrometer Cable Connector O031 Airlock Inside Hatch Closer O032 Airlock Depressurization Actuator O033 Airlock Outside Hatch Opener O034 Rail/Boom Extension Actuator O035 Tinstrument Power Actuator O036 Spectrometer Control Actuator O037 Spectrometer Control Actuator O038 Spectrometer Fault Identifier **O039 Camera Installer **O040 Spectrometer Tester O041 Gas Temperature Chamber Assembler O042 Gas Temperature Chamber Installer **O040 Spectrometer Grating Remover O041 Spectrometer Grating Remover O042 Gas Temperature Chamber Installer O043 Spectrometer Grating Remover O044 Spectrometer Grating Installer O045 Film Cartridge Remover **O046 Film Cartridge Remover **O046 Film Cartridge Remover **O047 Oscilloscope Repairer O048 Oscilloscope Repairer O049 Oscilloscope Fault Identifier	0006	Spectrometer Installer
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O010 Airlock Inside Hatch Opener O011 Magnetometer Remover O012 VLF Sensor Remover O013 Probe Remover O014 Ion Trap Remover O015 Probe Gas Distribution Monitor O016 Particle Sensor Repairer O017 Particle Sensor Remover O018 VLF Sensor Repairer O019 Gas Temperature Chamber Remover O020 Particle Sensor Translocator O021 VLF Sensor Translocator O021 VLF Sensor Translocator O022 Magnetometer Translocator O023 Probe Translocator O024 Ion Trap Translocator O025 Gas Temperature Chamber Translocator VT Camera Translocator O026 TV Camera Translocator O027 Photometer Translocator O028 Spectrometer Cable Selector O029 Spectrometer Cable Router O030 Spectrometer Cable Router O030 Spectrometer Cable Connector O031 Airlock Inside Hatch Closer O032 Airlock Depressurization Actuator O033 Airlock Outside Hatch Opener O034 Rail/Boom Extension Actuator O035 Instrument Power Actuator VO036 Spectrometer Control Actuator O037 Spectrometer Control Actuator O038 Spectrometer Fault Identifier VO039 Camera Installer VO040 Spectrometer Tester O041 Gas Temperature Chamber Assembler O042 Gas Temperature Chamber Installer O043 Spectrometer Grating Remover O044 Spectrometer Grating Remover O044 Spectrometer Grating Installer O045 Film Cartridge Remover VO046 Film Cartridge Remover VO047 Oscilloscope Repairer O048 Oscilloscope Repairer O049 Oscilloscope Fault Identifier	8000	Spectrometer Translocator
0011 Magnetometer Remover 0012 VLF Sensor Remover 0013 Probe Remover 0014 Ion Trap Remover 0015 Probe Gas Distribution Monitor 0016 Particle Sensor Repairer 0017 Particle Sensor Remover 0018 VLF Sensor Repairer 0019 Gas Temperature Chamber Remover 0020 Particle Sensor Translocator 0021 VLF Sensor Translocator 0022 Magnetometer Translocator 0023 Probe Translocator 0024 Ion Trap Translocator 0025 Gas Temperature Chamber Translocator 0026 TV Camera Translocator 0027 Photometer Translocator 0028 Spectrometer Cable Selector 0029 Spectrometer Cable Router 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator 0036 Spectrometer Control Actuator 0037 Spectrometer Fault Identifier *0038 Spectrometer Fault Identifier *0039 Camera Installer *0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Remover *0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 0049 Ion Trap Installer	0009	Airlock Status Monitor
0012 VLF Sensor Remover 0013 Probe Remover 0014 Ion Trap Remover 0015 Probe Gas Distribution Monitor 0016 Particle Sensor Repairer 0017 Particle Sensor Remover 0018 VLF Sensor Repairer 0019 Gas Temperature Chamber Remover 0020 Particle Sensor Translocator 0021 VLF Sensor Translocator 0022 Magnetometer Translocator 0023 Probe Translocator 0024 Ion Trap Translocator 0025 Gas Temperature Chamber Translocator 0026 TV Camera Translocator 0027 Photometer Translocator 0028 Spectrometer Cable Selector 0029 Spectrometer Cable Router 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator 0036 Spectrometer Control Actuator 0037 Spectrometer Fault Identifier *0038 Spectrometer Fault Identifier *0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover 0046 Film Cartridge Remover 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier	0010	Airlock Inside Hatch Opener
0013 Probe Remover 0014 Ion Trap Remover 0015 Probe Gas Distribution Monitor 0016 Particle Sensor Repairer 0017 Particle Sensor Remover 0018 VLF Sensor Repairer 0019 Gas Temperature Chamber Remover 0020 Particle Sensor Translocator 0021 VLF Sensor Translocator 0022 Magnetometer Translocator 0023 Probe Translocator 0024 Ion Trap Translocator 0025 Gas Temperature Chamber Translocator 0026 TV Camera Translocator 0027 Photometer Translocator 0028 Spectrometer Cable Selector 0029 Spectrometer Cable Router 0030 Spectrometer Cable Router 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator **0036 Spectrometer Control Actuator 0037 Spectrometer Control Actuator 0038 Spectrometer Fault Identifier **0039 Camera Installer **0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover **0046 Film Cartridge Remover **0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 0049 Ion Trap Installer	0011	Magnetometer Remover
O014 Ion Trap Remover O015 Probe Gas Distribution Monitor O016 Particle Sensor Repairer O017 Particle Sensor Remover O018 VLF Sensor Repairer O019 Gas Temperature Chamber Remover O020 Particle Sensor Translocator O021 VLF Sensor Translocator O022 Magnetometer Translocator O023 Probe Translocator O024 Ion Trap Translocator O025 Gas Temperature Chamber Translocator O026 TV Camera Translocator O027 Photometer Translocator O028 Spectrometer Cable Selector O029 Spectrometer Cable Router O030 Spectrometer Cable Connector O031 Airlock Inside Hatch Closer O032 Airlock Depressurization Actuator O033 Airlock Outside Hatch Opener O034 Rail/Boom Extension Actuator O035 Instrument Power Actuator VO036 Spectrometer Control Actuator VO037 Spectrometer Fault Identifier *O039 Camera Installer *O040 Spectrometer Tester O041 Gas Temperature Chamber Assembler O042 Gas Temperature Chamber Installer VO043 Spectrometer Grating Remover VO044 Spectrometer Grating Remover VO045 Film Cartridge Remover *O046 Film Cartridge Installer O047 Oscilloscope Repairer O048 Oscilloscope Repairer O049 Oscilloscope Fault Identifier	0012	VLF Sensor Remover
O015 Probe Gas Distribution Monitor O016 Particle Sensor Repairer O017 Particle Sensor Remover O018 VLF Sensor Repairer O019 Gas Temperature Chamber Remover O020 Particle Sensor Translocator O021 VLF Sensor Translocator O022 Magnetometer Translocator O023 Probe Translocator O024 Ion Trap Translocator O025 Gas Temperature Chamber Translocator O026 TV Camera Translocator O027 Photometer Translocator O028 Spectrometer Cable Selector O029 Spectrometer Cable Router O030 Spectrometer Cable Connector O031 Airlock Inside Hatch Closer O032 Airlock Depressurization Actuator O033 Airlock Outside Hatch Opener O034 Rail/Boom Extension Actuator O035 Instrument Power Actuator **O036 Spectrometer Control Actuator O037 Spectrometer Control Actuator **O038 Spectrometer Fault Identifier **O040 Spectrometer Tester O041 Gas Temperature Chamber Assembler O042 Gas Temperature Chamber Installer O043 Spectrometer Grating Remover O044 Spectrometer Grating Installer O045 Film Cartridge Remover **O046 Film Cartridge Remover **O046 Film Cartridge Installer O047 Oscilloscope Repairer O048 Oscilloscope Fault Identifier O049 Ion Trap Installer	0013	Probe Remover
0016 Particle Sensor Repairer 0017 Particle Sensor Remover 0018 VLF Sensor Repairer 0019 Gas Temperature Chamber Remover 0020 Particle Sensor Translocator 0021 VLF Sensor Translocator 0022 Magnetometer Translocator 0023 Probe Translocator 0024 Ion Trap Translocator 0025 Gas Temperature Chamber Translocator 0026 TV Camera Translocator 0027 Photometer Translocator 0028 Spectrometer Cable Selector 0029 Spectrometer Cable Router 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator 0036 Spectrometer Control Actuator 0037 Spectrometer Pault Identifier *0038 Spectrometer Tester 0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier	0014	Ion Trap Remover
O017 Particle Sensor Remover O018 VLF Sensor Repairer O019 Gas Temperature Chamber Remover O020 Particle Sensor Translocator O021 VLF Sensor Translocator O022 Magnetometer Translocator O023 Probe Translocator O024 Ion Trap Translocator O025 Gas Temperature Chamber Translocator VC Camera Translocator O027 Photometer Translocator O028 Spectrometer Cable Selector O029 Spectrometer Cable Router O030 Spectrometer Cable Connector O031 Airlock Inside Hatch Closer O032 Airlock Depressurization Actuator O033 Airlock Outside Hatch Opener O034 Rail/Boom Extension Actuator O035 Instrument Power Actuator VO036 Spectrometer Control Actuator O037 Spectrometer Pault Identifier *0039 Camera Installer *0040 Spectrometer Tester O041 Gas Temperature Chamber Assembler O042 Gas Temperature Chamber Installer O043 Spectrometer Grating Remover O044 Spectrometer Grating Installer O045 Film Cartridge Remover *0046 Film Cartridge Installer O047 Oscilloscope Repairer O048 Oscilloscope Fault Identifier	0015	Probe Gas Distribution Monitor
O018 VLF Sensor Repairer O019 Gas Temperature Chamber Remover O020 Particle Sensor Translocator O021 VLF Sensor Translocator O022 Magnetometer Translocator O023 Probe Translocator O024 Ion Trap Translocator O025 Gas Temperature Chamber Translocator VCamera Translocator O027 Photometer Translocator O028 Spectrometer Cable Selector O029 Spectrometer Cable Router O030 Spectrometer Cable Connector O031 Airlock Inside Hatch Closer O032 Airlock Depressurization Actuator O033 Airlock Outside Hatch Opener O034 Rail/Boom Extension Actuator O035 Instrument Power Actuator VO036 Spectrometer Control Actuator O037 Spectrometer Control Actuator VO038 Spectrometer Pault Identifier VO039 Camera Installer VO040 Spectrometer Tester O041 Gas Temperature Chamber Assembler O042 Gas Temperature Chamber Installer O043 Spectrometer Grating Remover O044 Spectrometer Grating Installer O045 Film Cartridge Remover VO046 Film Cartridge Installer O047 Oscilloscope Repairer O048 Oscilloscope Fault Identifier O049 Ion Trap Installer	0016	Particle Sensor Repairer
O019 Gas Temperature Chamber Remover O020 Particle Sensor Translocator O021 VLF Sensor Translocator O022 Magnetometer Translocator O023 Probe Translocator O024 Ion Trap Translocator O025 Gas Temperature Chamber Translocator **O026 TV Camera Translocator O027 Photometer Translocator O028 Spectrometer Cable Selector O029 Spectrometer Cable Router O030 Spectrometer Cable Router O031 Airlock Inside Hatch Closer O032 Airlock Depressurization Actuator O033 Airlock Outside Hatch Opener O034 Rail/Boom Extension Actuator O035 Instrument Power Actuator **O036 Spectrometer Control Actuator O037 Spectrometer Control Actuator O038 Spectrometer Operating Status Monitor **O038 Spectrometer Fault Identifier **O040 Spectrometer Tester O041 Gas Temperature Chamber Assembler O042 Gas Temperature Chamber Installer O043 Spectrometer Grating Remover O044 Spectrometer Grating Installer O045 Film Cartridge Remover **O046 Film Cartridge Installer O047 Oscilloscope Repairer O048 Oscilloscope Fault Identifier Ion Trap Installer	0017	Particle Sensor Remover
O019 Gas Temperature Chamber Remover O020 Particle Sensor Translocator O021 VLF Sensor Translocator O022 Magnetometer Translocator O023 Probe Translocator O024 Ion Trap Translocator O025 Gas Temperature Chamber Translocator **O026 TV Camera Translocator O027 Photometer Translocator O028 Spectrometer Cable Selector O029 Spectrometer Cable Router O030 Spectrometer Cable Router O031 Airlock Inside Hatch Closer O032 Airlock Depressurization Actuator O033 Airlock Outside Hatch Opener O034 Rail/Boom Extension Actuator O035 Instrument Power Actuator **O036 Spectrometer Control Actuator O037 Spectrometer Control Actuator O038 Spectrometer Operating Status Monitor **O038 Spectrometer Fault Identifier **O040 Spectrometer Tester O041 Gas Temperature Chamber Assembler O042 Gas Temperature Chamber Installer O043 Spectrometer Grating Remover O044 Spectrometer Grating Installer O045 Film Cartridge Remover **O046 Film Cartridge Installer O047 Oscilloscope Repairer O048 Oscilloscope Fault Identifier Ion Trap Installer	0018	VLF Sensor Repairer
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O023 Probe Translocator O024 Ion Trap Translocator O025 Gas Temperature Chamber Translocator *O026 TV Camera Translocator O027 Photometer Translocator O028 Spectrometer Cable Selector O029 Spectrometer Cable Router O030 Spectrometer Cable Connector O031 Airlock Inside Hatch Closer O032 Airlock Depressurization Actuator O033 Airlock Outside Hatch Opener O034 Rail/Boom Extension Actuator O035 Instrument Power Actuator **0036 Spectrometer Control Actuator O037 Spectrometer Operating Status Monitor **0038 Spectrometer Fault Identifier **0039 Camera Installer **0040 Spectrometer Tester O041 Gas Temperature Chamber Assembler O042 Gas Temperature Chamber Installer O043 Spectrometer Grating Remover O044 Spectrometer Grating Installer O045 Film Cartridge Remover **0046 Film Cartridge Installer O047 Oscilloscope Repairer O048 Oscilloscope Fault Identifier	0021	VLF Sensor Translocator
O024	0022	Magnetometer Translocator
*0025 Gas Temperature Chamber Translocator *0026 TV Camera Translocator 0027 Photometer Translocator 0028 Spectrometer Cable Selector 0029 Spectrometer Cable Router 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator *0036 Spectrometer Control Actuator 0037 Spectrometer Operating Status Monitor *0038 Spectrometer Fault Identifier *0039 Camera Installer *0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 10049 Ion Trap Installer	0023	Probe Translocator
*0026 TV Camera Translocator 0027 Photometer Translocator 0028 Spectrometer Cable Selector 0029 Spectrometer Cable Router 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator *0036 Spectrometer Control Actuator 0037 Spectrometer Operating Status Monitor *0038 Spectrometer Fault Identifier *0039 Camera Installer *0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 10049 Ion Trap Installer	0024	Ion Trap Translocator
*0026 TV Camera Translocator 0027 Photometer Translocator 0028 Spectrometer Cable Selector 0029 Spectrometer Cable Router 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator *0036 Spectrometer Control Actuator 0037 Spectrometer Operating Status Monitor *0038 Spectrometer Fault Identifier *0039 Camera Installer *0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 10049 Ion Trap Installer	0025	Gas Temperature Chamber Translocator
Spectrometer Cable Selector O029 Spectrometer Cable Router O030 Spectrometer Cable Connector O031 Airlock Inside Hatch Closer O032 Airlock Depressurization Actuator O033 Airlock Outside Hatch Opener O034 Rail/Boom Extension Actuator O035 Instrument Power Actuator **0036 Spectrometer Control Actuator O037 Spectrometer Operating Status Monitor **0038 Spectrometer Fault Identifier **0039 Camera Installer **0040 Spectrometer Tester O041 Gas Temperature Chamber Assembler O042 Gas Temperature Chamber Installer O043 Spectrometer Grating Remover O044 Spectrometer Grating Installer O045 Film Cartridge Remover **0046 Film Cartridge Installer O047 Oscilloscope Repairer O048 Oscilloscope Fault Identifier O049 Ion Trap Installer	<b>*</b> 0026	
Spectrometer Cable Router 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator *0036 Spectrometer Control Actuator 0037 Spectrometer Operating Status Monitor *0038 Spectrometer Fault Identifier *0039 Camera Installer *0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 10049 Ion Trap Installer	0027	Photometer Translocator
Spectrometer Cable Router 0030 Spectrometer Cable Connector 0031 Airlock Inside Hatch Closer 0032 Airlock Depressurization Actuator 0033 Airlock Outside Hatch Opener 0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator *0036 Spectrometer Control Actuator 0037 Spectrometer Operating Status Monitor *0038 Spectrometer Fault Identifier *0039 Camera Installer *0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 10049 Ion Trap Installer	0028	Spectrometer Cable Selector
O030 Spectrometer Cable Connector O031 Airlock Inside Hatch Closer O032 Airlock Depressurization Actuator O033 Airlock Outside Hatch Opener O034 Rail/Boom Extension Actuator O035 Instrument Power Actuator **0036 Spectrometer Control Actuator O037 Spectrometer Operating Status Monitor **0038 Spectrometer Fault Identifier **0039 Camera Installer **0040 Spectrometer Tester O041 Gas Temperature Chamber Assembler O042 Gas Temperature Chamber Installer O043 Spectrometer Grating Remover O044 Spectrometer Grating Installer O045 Film Cartridge Remover **0046 Film Cartridge Installer O047 Oscilloscope Repairer O048 Oscilloscope Fault Identifier O049 Ion Trap Installer	0029	
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0034 Rail/Boom Extension Actuator 0035 Instrument Power Actuator *0036 Spectrometer Control Actuator 0037 Spectrometer Operating Status Monitor *0038 Spectrometer Fault Identifier *0039 Camera Installer *0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 0049 Ion Trap Installer	0032	Airlock Depressurization Actuator
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*0036 Spectrometer Control Actuator 0037 Spectrometer Operating Status Monitor *0038 Spectrometer Fault Identifier *0039 Camera Installer *0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 0049 Ion Trap Installer	0034	
0037 Spectrometer Operating Status Monitor *0038 Spectrometer Fault Identifier *0039 Camera Installer *0040 Spectrometer Tester 0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 0049 Ion Trap Installer	0035	Instrument Power Actuator
*0038 Spectrometer Fault Identifier  *0039 Camera Installer  *0040 Spectrometer Tester  0041 Gas Temperature Chamber Assembler  0042 Gas Temperature Chamber Installer  0043 Spectrometer Grating Remover  0044 Spectrometer Grating Installer  0045 Film Cartridge Remover  *0046 Film Cartridge Installer  0047 Oscilloscope Repairer  0048 Oscilloscope Fault Identifier  0049 Ion Trap Installer	<b>*</b> 0036	Spectrometer Control Actuator
*0038 Spectrometer Fault Identifier  *0039 Camera Installer  *0040 Spectrometer Tester  0041 Gas Temperature Chamber Assembler  0042 Gas Temperature Chamber Installer  0043 Spectrometer Grating Remover  0044 Spectrometer Grating Installer  0045 Film Cartridge Remover  *0046 Film Cartridge Installer  0047 Oscilloscope Repairer  0048 Oscilloscope Fault Identifier  0049 Ion Trap Installer	0037	Spectrometer Operating Status Monitor
*0039 Camera Installer  *0040 Spectrometer Tester  0041 Gas Temperature Chamber Assembler  0042 Gas Temperature Chamber Installer  0043 Spectrometer Grating Remover  0044 Spectrometer Grating Installer  0045 Film Cartridge Remover  *0046 Film Cartridge Installer  0047 Oscilloscope Repairer  0048 Oscilloscope Fault Identifier  0049 Ion Trap Installer	<b>*</b> 0038	
0041 Gas Temperature Chamber Assembler 0042 Gas Temperature Chamber Installer 0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 0049 Ion Trap Installer	<b>*</b> 0039	=
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0043 Spectrometer Grating Remover 0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 0049 Ion Trap Installer	0042	
0044 Spectrometer Grating Installer 0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 0049 Ion Trap Installer	0043	
0045 Film Cartridge Remover *0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 0049 Ion Trap Installer	0044	
*0046 Film Cartridge Installer 0047 Oscilloscope Repairer 0048 Oscilloscope Fault Identifier 0049 Ion Trap Installer	0045	
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0049 Ion Trap Installer		
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0051	Magnetometer Installer
0052	VLF Sensor Installer
0053	Photometer Unstower
*0054	TV Camera Unstower
0055	Gas Temperature Chamber Unstower
0056	Ion Trap Unstower
0057	Probe Unstower
0057	Magnetometer Unstower
0059	VLF Sensor Unstower
	Particle Sensor Unstower
0060	
0061	Spacecraft Exterior Translationer
0062	Photometer Stower
0063	Spectrometer Stower
*0064	TV Camera Stower
0065	Gas Temperature Chamber Stower
0066	Ion Trap Stower
0067	Probe Stower
0068	Magnetometer Stower
0069	VLF Sensor Stower
0070	Particle Sensor Stower
0071	Calibration Equipment Installer
*0072	Spectrometer Calibrator
0073	Spectrometer Optics Inspector
0074	Camera Lens Inspector
0075	Photometer Optics Inspector
0076	TV Camera Optics Inspector
0077	Photometer Assembly Inspector
0078	Spectrometer Assembly Inspector
*0079	TV Camera Inspector
0080	Gas Temperature Chamber Inspector
0081	Ion Trap Assembly Inspector
0082	Probe Assembly Inspector
0083	Magnetometer Assembly Inspector
0084	VLF Sensor Assembly Inspector
0085	Particle Sensor Assembly Inspector
0086	Photometer Calibrator
0087	Gas Temperature Chamber Calibrator
	Ion Tron Colibrator
0088	Ion Trap Calibrator
0089	Probe Calibrator
0090	Magnetometer Calibrator
0091	VLF Sensor Calibrator
0092	Particle Sensor Calibrator
0093	Optical Equipment Cleaner
0094	Photometer Optics Cleaner
<b>*</b> 0095	Spectrometer Optics Cleaner
<b>*</b> 0096	TV Camera Optics Cleaner
<b>*</b> 0097	Camera Lens (Optics) Cleaner
0098	Magnetometer Repairer
0099	Probe Repairer
0100	Gas Temperature Chamber Repairer



#0101-0150

Gas Temperature Chamber Fault Identifier 0101 0102 Ion Trap Fault Identifier 0103 Probe Fault Identifier Magnetometer Fault Identifier 0104 VLF Sensor Fault Identifier 0105 0106 Electronic Instruments Tester Photometer Module Remover 0107 Photometer Module Installer 0108 \*0109 Spectrometer Module Remover \*0110 Spectrometer Module Installer TV Camera Module Remover \*0111 TV Camera Module Installer \*0112 Gas Temperature Chamber Module Remover 0113 0114 Gas Temperature Chamber Module Installer 0115 Ion Trap Module Remover 0116 Ion Trap Module Installer Probe Module Remover 0117 0118 Probe Module Installer 0119 Magnetometer Module Remover 0120 Magnetometer Module Installer 0121 VLF Sensor Module Remover 0122 VLF Sensor Module Installer 0123 Particle Sensor Module Remover Particle Sensor Module Installer 0124 Gas Canister Unstower 0125 0126 Gas Canister Translocator 0127 Gas Canister Cable Selector Gas Canister Cable Router 0128 0129 Gas Canister Cable Connector 0130 Gas Canister Installer 0131 Rail/Boom Retraction Actuator 0132 Airlock Outside Hatch Closer 0133 Airlock Pressurization Actuator 0134 Spectrometer Cable Disconnector 0135 Gas Canister Cable Disconnector 0136 Gas Canister Remover 0137 Gas Canister Stower 0138 Rail/Boom Position Monitor 0139 Instrument Power Monitor 0140 Particle Sensor Installer 0141 Particle Sensor Deployer 0142 Spacecraft Airlock Translationer 0143 Particle Sensor Cable Selector 0144 Particle Sensor Cable Router 0145 Particle Sensor Cable Connector 0146 Particle Sensor Aligner 0147 Particle Sensor Optics Calibrator 0148 Oscilloscope Unstower 0149 Oscilloscope Installer 0150 Particle Sensor Retractor



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#### FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0151-0200

Film Cartridge Stower 0151 Cable Stower 0152 Oscilloscope Stower 0153 0154 Camera Stower 0155 Particle Sensor Optics Inspector Particle Sensor Optics Cleaner 0156 0157 Particle Sensor Fault Identifier Camera Module Remover \*0158 Oscilloscope Module Remover 0159 Camera Module Installer \*0160 Oscilloscope Module Installer 0161 0162 Telescope Baffle Deployment Actuator Telescope Baffle Status Monitor 0163 0164 SITOS Unstower SITOS Translocator 0165 SITOS Installer 0166 SITOS Tester 0167 SITOS Calibrator 0168 0169 SITOS Grating Remover 0170 SITOS Grating Installer 0171 Telescope Baffle Retraction Actuator 0172 Launch Restraint Installer SITOS Remover 0173 SITOS Stower 0174 0175 Telescope Coverer Spectrometer Grating Inspector 0176 0177 SITOS Grating Inspector 0178 Telescope Optics Inspector 0179 SITOS Optics Inspector 0180 SITOS Assembly Inspector Camera Assembly Inspector 0181 SITOS Module Inspector 0182 SITOS Module Remover 0183 SITOS Module Installer 0184 0185 Ion Trap Repairer Combustible Gas Distribution Monitor 0186 \*0187 Telescope Module Remover \*0188 Telescope Module Installer 0189 Spectrometer Adjuster 0190 Oscilloscope Adjuster 0191 Amplifier Adjuster Phase Shifter Adjuster 0192 0193 Phase Sensitive Detector Adjuster 0194 Null Signal System Adjuster 0195 A/D Converter Adjuster 0196 Molecular Beam Scattering Device Assembler 0197 Molecular Beam Scattering Device Disassembler Molecular Beam Scattering Device Installer 0198 0199 Mounting Platform Installer

Instrument Pointing Direction Monitor



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0201	Instrument Pointing Direction Controller
0202	Tape Recorder Actuator
0203	Tape Cartridge Stower
*0204	Camera Mode Monitor
0205	Molecular Beam Scattering Data Analyst
*0206	Radio Communicator
0207	Molecular Beam Scattering Data Communicator
0208	Molecular Beam Scattering Research Planner
*0209	Scanner Mode Monitor
0210	Molecular Beam Scattering Device Inspector
0211	Molecular Beam Scattering Device Fault Identifier
*0212	TV Camera Mode Monitor
0213	Amplifier Fault Identifier
0214	Phase Shifter Fault Identifier
0215	Phase Sensitive Detector Fault Identifier
0216	Null Signal System Fault Identifier
0217	A/D Converter Fault Identifier
0218	Molecular Beam Scattering Device Module Remover
0219	Molecular Beam Scattering Device Module Installer
0220	Amplifier Module Remover
0221	Amplifier Module Installer
0222	Phase Shifter Module Remover
0223	Phase Shifter Module Installer
0224	Phase Sensitive Detector Module Remover
0225	Phase Sensitive Detector Module Installer
0226	A/D Converter Module Remover
0227	A/D Converter Module Installer
0228	Null Signal System Module Remover
0229	Null Signal System Module Installer
0230	Gas-Surface Interaction Device Unstower
0230	Gas-Surface Interaction Device Assembler
0232	Gas-Surface Interaction Device Installer
0232	Test Surface Remover
0233	Test Surface Installer
0235	Gas-Surface Interaction Device Plating Monitor
0233	Gas-Surface Interaction Device Plating Control Actuator
	Gas-Surface Interaction Device Disassembler
0237 0238	Test Surface Block Remover
0238	Test Surface Block Installer
0240	Plating Material Boat Remover
0241	Plating Material Boat Installer
0242	Gas-Surface Interaction Operations Monitor
0243	Gas-Surface Interaction Control Actuator
0244	Gas-Surface Interaction Control Deactuator
*0245	Camera Control Actuator
0246	Gas-Surface Interaction Data Recorder
0247	Gas-Surface Interaction Observer
0248	Gas-Surface Interaction Data Interpreter
0249	Gas-Surface Interaction Records Organizer
0250	Hard Copy Records Stower



0251	Data Recording Stower
0252	Astronomy C/D Console Self-Test Control Actuator
0253	Astronomy C/D Console Self-Test Display Monitor
0254	Telescope Drive Inspector
0255	Telescope Drive Tester
0256	Telescope Drive Control Actuator
0257	Telescope Drive Control Deactuator
0258	Camera Focusing Tester
0259	Spectrograph Focusing Tester
0260	Telescope Chamber Inspector
0261	Telescope Chamber Hatch Closer
0262	Telescope Chamber Status Monitor
0263	Telescope Chamber Depressurization Actuator
0264	Telescope Status Monitor
*0265	Telescope Mode Selector
0266	Telescope Mode Control Actuator
*0267	Spectrometer Mode Selector
*0268	TV Mode Selector
0269	Grating Mode Selector
0270	Band Filter Mode Selector
*0271	Camera Mode Selector
0272	Star Tracker Mode Selector
0273	Stellar Ultraviolet Observation Mode Selector
0274	Computer Mode Selector
0275	Amplifier Mode Selector
0276	Phase Shifter Mode Selector
0277	Spectrometer Mode Control Actuator
0278	TV Mode Control Actuator
0279 0280	Grating Mode Control Actuator Band Filter Mode Control Actuator
0280	Camera Mode Control Actuator
0282	Star Tracker Mode Control Actuator
0282	Stellar Ultraviolet Observation Mode Control Actuator
0284	Computer Mode Control Actuator
0285	Amplifier Mode Control Actuator
0286	Phase Shifter Mode Control Actuator
0287	Film Cartridge Inspector
0288	Film Cartridge Unstower
0289	Film Changing System Actuator
0290	Film Changing System Monitor
0291	Star Tracker Unstower
*0292	Camera Unstower
0293	Star Tracker Inspector
*0294	Camera Inspector
0295	Grating Inspector
0296	Band Filter Inspector
<b>*</b> 0297	Telescope Aligner
0298	Star Tracker Aligner
0299	Camera Aligner
0300	Spectrometer Aligner
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0301 Grating Aligner 0302 Band Filter Aligner ***0303 Telescope Unstower 0304 Star Tracker Cap Remover 0305 Star Tracker Installer ***0306 TV Camera Installer ***0307 Camera Cap Remover 0308 Telescope Cap Remover 0309 TV Camera Cap Remover 0310 Grating Remover 0311 Grating Installer 0311 Grating Installer 0312 Band Filter Remover 0313 Band Filter Remover 0314 Camera Remover 0315 Spectrometer Remover 0316 Telescope Chamber Outside Hatch Control Actuator 0317 Telescope Deployment Status Monitor 0318 Telescope Deployment Status Monitor 0319 Computer Control Deactuator ****0320 Telescope Control Deactuator 0321 Star Tracker Stower 0322 Telescope Position Monitor 0323 Telescope Pointing Status Monitor 0324 Telescope Pointing Status Monitor 0325 Telescope Pointing Status Monitor 0326 Stellar Ultraviolet Deserver 0327 Stellar Ultraviolet Evaluator ************************************		
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O325 Stellar Ultraviolet Observer O327 Stellar Ultraviolet Evaluator **0328 Film Processor O329 Film Evaluator O330 Stellar Ultraviolet Emission Classifier O331 Stellar Ultraviolet Research Planner O332 Stellar Ultraviolet Data Analyst O333 Star Tracker Controller **0334 TV Camera Controller **0335 Camera Controller **0336 Spectrometer Controller **0337 Telescope Controller 0338 Telescope System Controller 0339 Camera Focusing Monitor 0340 Spectrograph Focusing Monitor 0341 Camera Focusing Aligner 0342 Spectrograph Focusing Aligner 0343 Star Tracker Module Remover 0344 Star Tracker Module Installer **0345 TV System Module Remover 0346 TV System Module Remover 0347 Band Filter Module Remover 0348 Band Filter Module Installer 0349 Combustible Gas Mixing Controller		
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0349 Combustible Gas Mixing Controller		
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0350 Combustible Gas Mixture Stower		
	0350	Combustible Gas Mixture Stower



0351	Zero-G Combustion Research Planner
0352	Spectrograph Calibrator
0353	Gas Chromatograph Calibrator
0354	Combustible Gas Tube Filler
0355	Fire Detection Equipment Monitor
0356	Fire Control Equipment Controller
0357	Zero-G Combustion Control Actuator
0358	Zero-G Combustion Display Monitor
0359	Combustible Gas Distribution Control Actuator
0360	Temperature Measurement Observer
0361	Temperature Measurement Recorder
0362	Pressure Measurement Observer
0363	Pressure Measurement Recorder
0364	Flame Composition Measurement Observer
0365	Flame Composition Measurement Recorder
0366	Flame Visible Structure Observer
0367	Probe Gas Distribution Control Actuator
0368	Zero-G Combustion Data Analyst
0369	Zero-G Combustion Observer
0370	Zero-G Combustion Device Fault Identifier
0371	Zero-G Combustion Device Adjustor
0372	Spectrograph Fault Identifier
0373	Spectrograph Adjustor
0374	Gas Chromatograph Fault Identifier
0375	Gas Chromatograph Adjuster
*0376	Calorimeter Fault Identifier
0377	Calorimeter Adjustor
0378	Zero-G Combustion C/D Equipment Fault Identifier
0379	Zero-G Combustion C/D Equipment Adjuster
*0380	Calorimeter Calibrator
0381	Laser Fuel and Oxidizer Installer
0382	Contamination Coupon Translocator
0383	Contamination Coupon Installer
0384	Chemical Laser Installer
0385	Contamination Coupon Remover
0386	Chemical Laser Operation Monitor
0387	Contamination Coupon Sample Measurer
0388	Chemical Laser Control Actuator
0389	Chemical Laser Control Deactuator
0390	Zero-G Laser Operation Observer
*0391	Calorimeter Operation Monitor
*0392	Calorimeter Control Actuator
*0393	Calorimeter Control Deactuator
0394	Chemical Laser Temperature Monitor
0395	Gas Canister Deployment Control Actuator
0396	Gas Canister Deployment Monitor
0397	Physics Subsatellite Flight Controller
0398	Physics Subsatellite Flight Monitor
0399	Space Gas Reactions Research Planner
0400	Space Gas Reactions Observer
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0401	Chemical Canister Deployment Control Actuator
0402	Chemical Canister Deployment Monitor
0403	Chemical Canister Unstower
0404	Chemical Canister Translocator
0405	Photometer Installer
0406	Physics Subsatellite Instrumentation Monitor
0407	Physics Subsatellite Instrumentation Controller
0408	Instrument Power Deactuator
<b>*</b> 0409	Spectrometer Control Deactuator
0410	Probe Operating Status Monitor
0411	Probe Control Actuator
0412	Probe Control Deactuator
0413	Photometer Operating Status Monitor
0414	Photometer Control Actuator
0415	Photometer Control Deactuator
0416	Rail/Boom-Cloud Observer
0417	Rail/Boom-Cloud Position Determiner
0418	Physics Subsatellite-Cloud Observer
0419	Physics Subsatellite-Cloud Position Determiner
0420	Space Gas Reactions Data Monitor
0421	Space Gas Reactions Observation Director
0422	Chemical Canister Chemical Release Actuator
0423	Space Gas Reactions Data Recorder
0424	Refueling System Control Actuator
0425	Refueling System Control Deactuator
0426	Refueling System Monitor
0427	Teleoperator Refueling Control Actuator
0428	Teleoperator Refueling Control Deactuator
0429	Teleoperator Fuel Status Monitor
0430	Battery Charging System Control Actuator
0431	Battery Charging System Control Deactuator
0432	Battery Charging System Monitor
0433	Teleoperator Battery Charging Control Actuator
0434	Teleoperator Battery Charging Control Deactuator
0435	Teleoperator Battery Charge Status Monitor
0436	Teleoperator Subsystem Inspector
0437	Teleoperator Subsystem Tester
0438	Teleoperator Deployment Mechanism Monitor
0439	Teleoperator Deployment Control Actuator
0440	Docking Adapter Status Monitor
0441	Docking Adapter Release Control Actuator
0442	Teleoperator Systems Monitor
0443	Teleoperator Retrieval Mechanism Monitor
0444	Teleoperator Retrieval Control Actuator
0445	Teleoperator Flight Observer
0446	Teleoperator Flight Controller
0447	Teleoperator Performance Evaluator
0448	Teleoperator Deficiency Determiner
0449	Teleoperator Design Evaluator
0450	Teleoperator Design Planner
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Teleoperator/Man Interface Design Evaluator Teleoperator/Man Interface Design Planner Spacecraft External Surface Inspector Teleoperator Docking Observer Teleoperator Communication System Controller Teleoperator Communication System Evaluator Teleoperator Communication Deadzone Determiner Teleoperator Subsystem Adjuster Teleoperator System Inspector Teleoperator System Inspector Teleoperator System Inspector Teleoperator System Fault Identifier Teleoperator System Fault Identifier Teleoperator Manipulations Controller Lighting Adaptation Evaluator Teleoperator Video Systems Evaluator Teleoperator Video Systems Evaluator Teleoperator Video Control Actuator Teleoperator Video Acquisition Controller Task Board Docking Point Identifier Task Board Docking Point Identifier Task Board Subsatellite Observer Task Board Subsatellite Release Control Actuator Spacecraft Relative Velocities Determiner Teleoperator Camera Controller Task Board Subsatellite Release Control Actuator Teleoperator Camera Controller Teleoperator Attitude Status Monitor Teleoperator Attitude Status Monitor Teleoperator Docking Release Actuator Teleoperator Indocking Observer Teleoperator Stability Status Monitor Teleoperator Installer Laser Optics Installer Laser Optics Installer Laser Electronics Remover CM88 Laser Optics Installer Laser Electronics Remover CM89 Comm/Nav Subsatellite Launch Controller Laser Control Deactuator Protective Eyeglasses Donner Laser Communication Data Evaluator Laser Tracking Signal Monitor Laser Tracking Signal Monitor Radio Transmitter Assembler Radio Transmitter Assembler
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Uighting Adaptation Evaluator O466 Teleoperator Video Systems Evaluator O467 Teleoperator Video Control Actuator O468 Teleoperator Video Presentation Observer O469 Teleoperator Video Acquisition Controller O470 Task Board Docking Point Identifier O471 Teleoperator Video Control Deactuator O472 Task Board Observer O473 Task Board Subsatellite Observer O474 Task Board Subsatellite Release Control Actuator O475 Spacecraft Relative Velocities Determiner O476 Task Board Subsatellite Inspector O477 Teleoperator Camera Controller O478 Teleoperator Stability Status Monitor O479 Teleoperator Attitude Status Monitor O480 Teleoperator Undocking Observer O481 Teleoperator Docking Release Actuator O482 Teleoperator Manipulations Evaluator O483 Laser Optics Aligner O484 Laser Optics Installer U485 Laser Optics Installer U486 Laser Electronics Adjuster U487 Laser Electronics Adjuster U488 Laser Electronics Remover O489 Comm/Nav Subsatellite Launch Controller O490 Laser Control Deactuator O491 Protective Eyeglasses Donner U492 Laser Operating Status Monitor U493 Laser Tracking Signal Monitor U496 Laser Tracking System Controller O496 Radio Transmitter Assembler
Teleoperator Video Systems Evaluator O467 Teleoperator Video Control Actuator O468 Teleoperator Video Presentation Observer O469 Teleoperator Video Acquisition Controller O470 Task Board Docking Point Identifier O471 Teleoperator Video Control Deactuator O472 Task Board Observer O473 Task Board Subsatellite Observer O474 Task Board Subsatellite Release Control Actuator O475 Spacecraft Relative Velocities Determiner O476 Task Board Subsatellite Inspector O477 Teleoperator Camera Controller O478 Teleoperator Stability Status Monitor O479 Teleoperator Attitude Status Monitor O480 Teleoperator Undocking Observer O481 Teleoperator Docking Release Actuator O482 Teleoperator Manipulations Evaluator O483 Laser Optics Aligner O484 Laser Optics Installer O485 Laser Electronics Installer O486 Laser Electronics Remover O487 Laser Electronics Remover O488 Laser Electronics Remover O489 Comm/Nav Subsatellite Launch Controller O490 Laser Control Deactuator O491 Protective Eyeglasses Donner O492 Laser Operating Status Monitor O493 Laser Tracking Signal Monitor O494 Laser Tracking Signal Monitor O495 Radio Transmitter Assembler
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Task Board Observer Task Board Subsatellite Observer Task Board Subsatellite Release Control Actuator Spacecraft Relative Velocities Determiner Task Board Subsatellite Inspector Task Board Subsatellite Inspector Task Board Subsatellite Inspector Teleoperator Camera Controller Teleoperator Stability Status Monitor Teleoperator Attitude Status Monitor Teleoperator Undocking Observer Teleoperator Docking Release Actuator Teleoperator Manipulations Evaluator Teleoperator Manipulations Evaluator Ass Laser Optics Aligner Laser Optics Installer Laser Optics Remover Laser Electronics Installer Laser Electronics Remover Comm/Nav Subsatellite Launch Controller Laser Control Deactuator Protective Eyeglasses Donner Laser Operating Status Monitor Laser Tracking Signal Monitor Laser Tracking System Controller Radio Transmitter Assembler
Task Board Subsatellite Observer  0474 Task Board Subsatellite Release Control Actuator  0475 Spacecraft Relative Velocities Determiner  0476 Task Board Subsatellite Inspector  0477 Teleoperator Camera Controller  0478 Teleoperator Stability Status Monitor  0479 Teleoperator Attitude Status Monitor  0480 Teleoperator Undocking Observer  0481 Teleoperator Docking Release Actuator  0482 Teleoperator Manipulations Evaluator  0483 Laser Optics Aligner  0484 Laser Optics Installer  0485 Laser Optics Remover  0486 Laser Electronics Installer  0487 Laser Electronics Adjuster  0488 Laser Electronics Remover  0489 Comm/Nav Subsatellite Launch Controller  0490 Laser Control Deactuator  0491 Protective Eyeglasses Donner  0492 Laser Operating Status Monitor  0493 Laser Communication Data Evaluator  0494 Laser Tracking Signal Monitor  0495 Laser Tracking System Controller  0496 Radio Transmitter Assembler
O474 Task Board Subsatellite Release Control Actuator O475 Spacecraft Relative Velocities Determiner O476 Task Board Subsatellite Inspector O477 Teleoperator Camera Controller O478 Teleoperator Stability Status Monitor O479 Teleoperator Attitude Status Monitor O480 Teleoperator Undocking Observer O481 Teleoperator Docking Release Actuator O482 Teleoperator Manipulations Evaluator O483 Laser Optics Aligner O484 Laser Optics Installer O485 Laser Optics Remover O486 Laser Electronics Installer O487 Laser Electronics Adjuster O488 Laser Electronics Remover O489 Comm/Nav Subsatellite Launch Controller O490 Laser Control Deactuator O491 Protective Eyeglasses Donner O492 Laser Operating Status Monitor O493 Laser Tracking Signal Monitor O494 Laser Tracking Signal Monitor O495 Laser Tracking System Controller O496 Radio Transmitter Assembler
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Teleoperator Docking Release Actuator  Teleoperator Manipulations Evaluator  Laser Optics Aligner  Laser Optics Installer  Laser Optics Remover  Laser Electronics Installer  Laser Electronics Adjuster  Laser Electronics Remover  Laser Electronics Remover  Laser Comm/Nav Subsatellite Launch Controller  Laser Control Deactuator  Protective Eyeglasses Donner  Laser Operating Status Monitor  Laser Communication Data Evaluator  Laser Tracking Signal Monitor  Laser Tracking System Controller  Radio Transmitter Assembler
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0494 Laser Tracking Signal Monitor 0495 Laser Tracking System Controller 0496 Radio Transmitter Assembler
0495 Laser Tracking System Controller 0496 Radio Transmitter Assembler
0496 Radio Transmitter Assembler
0497 Radio Transmitter Disassembler
0498 Radio Transmitter Module Remover
0499 Radio Transmitter Module Installer
0500 Radio Receiver Assembler



	FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING	#0501-0550
0501	Radio Receiver Disassembler	. 0301-0330
0501 0502	Radio Receiver Module Remover	
0502	Radio Receiver Module Installer	
0504	Radio Antenna Assembler	
0505	Radio Antenna Disassembler	
0506	Radio Antenna Module Remover	
0507	Radio Antenna Module Installer	
0508	Radio Antenna Deployment Control Actuator	
0509	Radio Antenna Translocator	
0510	Radio Antenna Installer	
0511	Radio Receiver Calibrator	
0512	Radio Frequency Control Actuator	
0513	MW Communications Research Planner	
0514	Radio Transceiver Control Deactuator	
0515	Meteorological Condition Determiner	
*0516	Meteorological Condition Observer	
0517	Radio Antenna Pointing Controller	
0518	MW Communications Data Evaluator	
*0519	Computer Module Remover	•
*0520	Computer Module Installer	
0521	Radio Transmitter Fault Identifier	
0522		
*0523	•	
0524 0525		
0525	Radio Transponder Assembler Interferometer Antenna Array Assembler	
0527	·	
0528	Radio Transponder Calibrator	
0529		
0530	Interferometer Antenna Array Installer	
0531	·	
0532	Radio Transponder Control Deactuator	
0533	Rādio Trānsponder Operating Status Monitor	
0534	Surveillance/S&R Data Processing Monitor	
0535	Surveillance/S&R Data Evaluator	
0536	Radio Transponder Repairer	
0537		
0538	Comm/Nav Subsatellite Repairer	
0539	Comm/Nav Subsatellite C/D Equipment Repairer	
*0540	Computer Repairer	
0541	Interferometer Antenna Array Repairer	
0542	Radio Transmitter Repairer	
0543	Radio Receiver Repairer	
0544	Radio Antenna Repairer	
0545	Satellite Navigation Equipment Module Remover	
0546	Satellite Navigation Equipment Module Installer	
0547	Radio Transmitter Remover	
0548 0549	Radio Transmitter Installer	
0549	Radio Antenna Remover Radio Receiver Remover	
0330	MAGIO RECEIVEL MEMOVEL	



0551	Radio Receiver Installer
. 0552	Code Generator Remover
0553	Code Generator Installer
0554	Frequency Synthesizer Remover
0555	Frequency Synthesizer Installer
0556	Precision Clock Remover
0557	Precision Clock Installer
0558	Comm/Nav Subsatellite Module Remover
0559	Comm/Nav Subsatellite Module Installer
0560	Comm/Nav Subsatellite Module Aligner
0561	Radio Antenna-Transmitter Calibrator
0562	Radio Transmitter Power Control Actuator
0563	Radio Receiver Power Control Actuator
0564	Radio Transmitter Stower
0565	Radio Receiver Stower
0566	Radio Antenna Stower
0567	Frequency Synthesizer Stower Code Generator Stower
0568	Precision Clock Stower
0569 0570	Comm/Nav Subsatellite Stower
0571	Radio Transmitter Power Control Deactuator
0572	Radio Receiver Power Control Deactuator
0573	Comm/Nav Subsatellite Flight Controller
0574	Radio Transmitter Operation Monitor
0575	Comm/Nav C/D Equipment Fault Identifier
0576	Frequency Synthesizer Fault Identifier
0577	Frequency Synthesizer Repairer
0578	Code Generator Fault Identifier
0579	Code Generator Repairer
0580	Precision Clock Fault Identifier
0581	Precision Clock Repairer
0582	Comm/Nav Subsatellite Fault Identifier
0583	Laser Transmitter Assembler
0584	Laser Transmitter Disassembler
0585	Laser Transmitter Module Remover
0586	Laser Transmitter Module Installer
0587	Laser Transmitter Remover
0588	Laser Transmitter Installer
0589	Laser Receiver Assembler
0590	Laser Receiver Disassembler
0591	Laser Receiver Module Remover
0592	Laser Receiver Module Installer
0593	Laser Receiver Remover
0594	Laser Receiver Installer
0595	Comm/Nav C/D Equipment Module Remover
0596	Comm/Nav C/D Equipment Module Installer
0597	Laser Transmitter Control Deactuator
0598	Laser Receiver Control Deactuator
0599	Laser Transmitter Controller
0600	Laser Radar Target Observer



Laser Radar Data Evaluator · 0601 Laser Radar Display Observer 0602 Map Observer 0603 Topographic Map-Match Determiner 0604 Laser Transmitter Calibrator 0605 0606 Laser Transmitter Optics Cleaner Laser Transmitter Fault Identifier 0607 0608 Laser Receiver Fault Identifier 0609 Computer Program Determiner 0610 Computer Program Controller \*0611 Radar Transmitter Unstower Radar Transmitter Assembler 0612 \*0613 Radar Transmitter Tester 0614 Radar Transmitter Installer \*0615 Radar Transmitter Module Remover Radar Transmitter Module Installer \*0616 0617 Radar Transmitter Remover Radar Transmitter Disassembler 0618 Radar Transmitter Stower 0619 0620 Radar Receiver Assembler 0621 Radar Receiver Disassembler 0622 Radar Receiver Installer \*0623 Radar Receiver Module Installer \*0624 Radar Receiver Module Remover 0625 Radar Receiver Remover 0626 Radar Transmitter Stower \*0627 Radar Receiver Tester Radar Transmitter Unstower \*0628 0629 Laser Transmitter Unstower 0630 Laser Transmitter Tester Laser Receiver Unstower 0631 0632 Laser Receiver Tester \*0633 TV Camera Tester 0634 Radiometer Assembler 0635 Radiometer Disassembler 0636 Radiometer Installer \*0637 Radiometer Module Installer \*0638 Radiometer Module Remover 0639 Radiometer Remover Radiometer Stower 0640 Radiometer Tester \*0641 \*0642 Radiometer Unstower 0643 Star Tracker Assembler \*0644 Radiometer Mode Monitor 0645 Star Tracker Remover 0646 Star Tracker Tester 0647 Inertial Navigation Sensor Installer 0648 Inertial Navigation Sensor Remover 0649 Inertial Navigation Sensor Stower 0650 Inertial Navigation Sensor Tester

Samuel Market Samuel

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0651-0700

Inertial Navigation Sensor Unstower 0651 0652 Magnetostatic Device Assembler \*0653 Polarimeter Mode Monitor 0654 Magnetostatic Device Installer 0655 Magnetostatic Device Module Installer Magnetostatic Device Module Remover 0656 0657 Magnetostatic Device Remover 0658 Magnetostatic Device Stower Magnetostatic Device Tester 0659 Magnetostatic Device Unstower 0660 \*0661 TV Camera Remover \*0662 Telemetry Equipment Control Actuator 0663 Telemetry Equipment Control Deactuator \*0664 Radar Transmitter Control Deactuator 0665 Radar Transmitter Translocator **\*** 0666 Radar Receiver Control Deactuator 0667 Radar Receiver Translocator Laser Transmitter Translocator 0668 0669 Laser Receiver Translocator 0670 Laser Receiver Stower 0671 Laser Transmitter Stower \* 0672 TV Camera Control Deactuator \* 0673 Radiometer Control Deactuator 0674 Radiometer Translocator 0675 Star Tracker Control Deactuator Star Tracker Translocator 0676 0677 Inertial Navigation Sensor Control Deactuator 0678 Inertial Navigation Sensor Translocator Magnetostatic Device Control Deactuator 0679 Magnetostatic Device Translocator 0680 0681 Comm/Nav C/D Equipment Control Deactuator 0682 Navigation Signal Comparison Evaluator \* 0683 Radar Transmitter Fault Identifier \* 0684 Radar Transmitter Repairer **\*** 0685 Radar Receiver Fault Identifier **\*** 0686 Radar Receiver Repairer 0687 Laser Transmitter Repairer Laser Receiver Repairer 0688 \* 0689 TV Camera Fault Identifier \* 0690 TV Camera Repairer \* 0691 Radiometer Fault Identifier \* 0692 Radiometer Repairer 0693 Star Tracker Fault Identifier 0694 Star Tracker Repairer 0695 Inertial Navigation Sensor Fault Identifier 0696 Inertial Navigation Sensor Repairer 0697 Magnetostatic Device Fault Identifier 0698 Magnetostatic Device Repairer 0699 Telemetry Equipment Fault Identifier 0700 Telemetry Equipment Repairer



#0701-0750

Microscope Fault Identifier 0701 Microscope Unstower 0702 0703 Microscope Stower Microscope Translocator 0704 Microscope Repairer 0705 0706 Power Monitoring Device Control Deactuator Power Monitoring Device Installer 0707 0708 Power Monitoring Device Remover 0709 Power Monitoring Device Fault Identifier Power Monitoring Device Unstower 0710 0711 Power Monitoring Device Stower 0712 Power Monitoring Device Translocator 0713 Power Monitoring Device Repairer Waveform Modulator Control Deactuator 0714 0715 Waveform Modulator Module Installer Waveform Modulator Module Remover 0716 Waveform Modulator Installer 0717 Waveform Modulator Remover 0718 Waveform Modulator Fault Identifier 0719 0720 Waveform Modulator Unstower Waveform Modulator Stower 0721 0722 Waveform Modulator Translocator 0723 Waveform Modulator Repairer 0724 Spacecraft Plasma Probe Control Deactuator 0725 Spacecraft Plasma Probe Installer 0726 Spacecraft Plasma Probe Remover 0727 Spacecraft Plasma Probe Fault Identifier 0728 Spacecraft Plasma Probe Unstower 0729 Spacecraft Plasma Probe Stower 0730 Spacecraft Plasma Probe Translocator 0731 Spacecraft Plasma Probe Repairer 0732 Temperature Monitoring Device Control Deactuator 0733 Temperature Monitoring Device Installer Temperature Monitoring Device Fault Identifier 0734 0735 Temperature Monitoring Device Remover 0736 Temperature Monitoring Device Unstower 0737 Temperature Monitoring Device Stower 0738 Temperature Monitoring Device Translocator Temperature Monitoring Device Repairer 0739 0740 Pressure Monitoring Device Control Deactuator Pressure Monitoring Device Installer 0741 0742 Pressure Monitoring Device Remover 0743 Pressure Monitoring Device Fault Identifier Pressure Monitoring Device Unstower 0744 0745 Pressure Monitoring Device Stower Pressure Monitoring Device Translocator 0746 0747 Pressure Monitoring Device Repairer 0748 Optical Monitoring Device Control Deactuator

Optical Monitoring Device Installer

Optical Monitoring Device Remover

0749 0750

]	FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING	#0751-0800
0751	Optical Monitoring Device Fault Identifier	
0752	Optical Monitoring Device Unstower	
0753	Optical Monitoring Device Stower	
0753	Optical Monitoring Device Translocator	
0755	Optical Monitoring Device Repairer	
0756	Microwave Transmitter Control Deactuator	
0757	Microwave Transmitter Condition Determiner	
0758	Microwave Transmitter Inspector	
0759	Microwave Transmitter Inspector Microwave Transmitter Module Installer	
0759	Microwave Transmitter Module Remover	
0761	Microwave Transmitter Module Remover Microwave Transmitter Installer	
0762	Microwave Transmitter Remover	
0763	Microwave Transmitter Fault Identifier	
0764	Microwave Transmitter Unstower	
0765	Microwave Transmitter Onstower  Microwave Transmitter Stower	
0766	Microwave Transmitter Stower Microwave Transmitter Translocator	
0767	Microwave Transmitter Repairer	
0767	Microwave Transmitter Repairer Microwave Test Structure Condition Determiner	
0769	Microwave Test Structure Inspector	
0709	Microwave Test Structure Module Installer	
0770	Microwave Test Structure Module Remover	
0771	Microwave Test Structure Installer	
0772	Microwave Test Structure Remover	
0773	Microwave Test Structure Unstower	
0774	Microwave Test Structure Stower	
0776	Microwave Test Structure Disassembler	
0770	Microwave Test Structure Assembler	
0777	Microwave Test Structure Translocator	
*0779	Spectrometer Repairer	
0780	Radio Receiver Cable Connector	
0781	RV Launch Cable Connector	
0782	Radio Transmitter Cable Connector	
0783	VSWR Measuring Equipment Cable Connector	
0783	Attitude Measuring Equipment Cable Connector	
0785	Data Recorder Cable Connector	
0786	Telemetry Cable Connector	
<b>*</b> 0787	Spectrometer Mode Monitor	
0788	Comm/Nav Subsatellite Launch Cable Connector	
0789	RV Fault Identifier	
0789	RV Repairer	
0791	VSWR Measuring Equipment Fault Identifier	
0791	Attitude Measuring Equipment Fault Identifier	
0793	Data Recorder Fault Identifier	
0794	Cable Fault Identifier	
<b>*</b> 0795	Electronic Equipment Fault Identifier	
0796	VSWR Measuring Equipment Repairer	
0796		
0797	Attitude Measuring Equipment Repairer	
0798	Data Recorder Repairer	
0800	Cable Repairer Radar Receiver Cable Connector	
0000	Radal Received Gable Connector	



	0801	Radar Antenna Remover
	0802	Radar Antenna Installer
	0803	Radar Transmitter Cable Connector
	0804	Radar Antenna Cable Connector
	0805	Radar Antenna Fault Identifier
	0806	Radar Antenna Repairer
	0807	Radar Antenna-Transmitter Calibrator
	0808	Radar Transmitter Power Control Actuator
	0809	Radar Receiver Power Control Actuator
	0810	Radar Transmitter Power Control Deactuator
	0811	Radar Receiver Power Control Deactuator
,	0812	Radar Transmitter Operation Monitor
	0813	Comm/Nav System Tester
	0814	Comm/Nav System Test Monitor
	0815	
		Radio Antenna Unstower
	0816	Radar Antenna Unstower
	0817	Radar Antenna Translocator
	0818	Radar Antenna Assembler
	0819	Radar Antenna Disassembler
	0820	Telemetry Equipment Module Remover
	0821	Telemetry Equipment Module Installer
.1.	0822	Cloud Chamber Unstower
ж	0823	Scanner Unstower
	0824	Polarimeter Unstower
×	0825	Sferics Detector Unstower
	0826	Scatterometer Unstower
	0827	Microscope Inspector
	0828	Scanner Inspector
፠	0829	Radiometer Inspector
	0830	Scatterometer Inspector
*	0831	Polarimeter Inspector
*	0832	Sferics Detector Inspector
ĸ	0833	Spectrometer Inspector
	0834	Cloud Chamber Inspector
	0835	Microscope Calibrator
	0836	Scanner Calibrator
×	0837	Radiometer Calibrator
	0838	Scatterometer Calibrator
	0839	Polarimeter Calibrator
	0840	Sferics Detector Calibrator
	0841	Cloud Chamber Calibrator
*	0842	Scanner Control Actuator
	0843	Radiometer Control Actuator
	0844	Polarimeter Control Actuator
	0845	Sferics Detector Control Actuator
	0846	
		Telescope Control Actuator
	0847	Computer Control Actuator
	0848	Camera Control Deactuator
•	0849	Scanner Control Deactuator
	0850	Scatterometer Control Actuator

#0851-0900

```
Scatterometer Control Deactuator
 0851
          Film Stower
 ¢0852
          Sferics Detector Control Deactuator
 *0853
          Cloud Chamber Control Deactuator
  0854
          Cloud Chamber Control Actuator
  0855
          Scanner Stower
  0856
          Scatterometer Stower
  0857
          Sferics Detector Stower
  0858
          Telescope Stower
  0859
          Cloud Chamber Stower
  0860
          Cloud Physics Process Observer
  0861
*0862
          Tape Recorder Controller
  0863
          Cloud Physics Observation Communicator
  0864
          Topographic Feature Observer
  0865
          Atmospheric Feature Observer
  0866
          Topographic Feature Determiner
 0867
          Atmospheric Feature Determiner
 0868
          Observation Condition Observer
*0869
          Scanner Data Quality Monitor
*0870
          Radiometer Data Quality Monitor
 0871
          Scatterometer Data Quality Monitor
*0872
          Spectrometer Data Quality Monitor
*0873
          Polarimeter Data Quality Monitor
*0874
          Telescope Operation Evaluator
*0875
          Camera Operation Evaluator
*0876
          Scanner Operation Evaluator
*0877
          Radiometer Operation Evaluator
 0878
          Scatterometer Operation Evaluator
*0879
          Spectrometer Operation Evaluator
* 0880
          Polarimeter Operation Evaluator
          Sferics Detector Operation Evaluator
 0881
* 0882
          Sferics Detector Data Quality Monitor
 0883
          Microscope Optics Cleaner
* 0884
          Scanner Optics Cleaner
* 0885
          Telescope Fault Identifier
* 0886
          Camera Fault Identifier
* 0887
          Scanner Fault Identifier
* 0888
          Scatterometer Fault Identifier
* 0889
          Polarimeter Fault Identifier
* 0890
         Sferics Detector Fault Identifier
* 0891
          Optical Equipment Fault Identifier
 0892
         TV Camera Calibrator
 0893
         Camera Disassembler
 0894
         Camera Assembler
* 0895
         Telescope Presentation Observer
* 0896
         TV Presentation Observer
* 0897
         Scanner Presentation Observer
* 0898
         Radiometer Presentation Observer
* 0899
         TV Camera Control Actuator
 0900
         TV Camera Disassembler
```



#### FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING TV Camera Assembler 0901 Scanner Disassembler 0902 0903 Scanner Assembler Scanner Module Remover **\***0904 Scanner Module Installer \*0905 Polarimeter Disassembler 0906 Polarimeter Assembler 0907 Polarimeter Module Remover \*0908 Polarimeter Module Installer **\***0909 0910 Spectrometer Disassembler 0911 Spectrometer Assembler 0912 Telescope Disassembler 0913 Telescope Assembler \*0914 Polarimeter Presentation Observer \*0915 Spectrometer Presentation Observer **\***0916 Scanner Mode Selector \*0917 Radiometer Mode Selector \*0918 Polarimeter Mode Selector \*0919 Polarimeter Control Deactuator 0920 Data Photographic Quality Evaluator \*0921 Telescope Pointing Controller \* 0922 TV Data Quality Monitor **\*** 0923 TV Camera Operation Evaluator \* 0924 Radiometer Optics Cleaner \* 0925 Polarimeter Optics Cleaner \* 0926 Earth Survey C/D Equipment Module Remover \* 0927 Earth Survey C/D Equipment Module Installer \* 0928 Earth Survey C/D Equipment Fault Identifier 0929 TV Camera Aligner 0930 Radar Transmitter Aligner 0931 Radar Receiver Aligner \* 0932 Radar Transmitter Inspector **\*** 0933 Radar Receiver Inspector Radar Presentation Observer \* 0934 \* 0935 Radar Transmitter Control Actuator Radar Receiver Control Actuator \* 0936 \* 0937 Sferics Detector Presentation Observer Radar Transmitter Mode Selector \* 0938 \* 0939 Radar Receiver Mode Selector \* 0940 Sferics Detector Mode Selector \* 0941 Forest Fire Disaster Identifier \* 0942 Telescope Mode Monitor \* 0943 Telescope Mode Recorder

#0901-0950

\* 0941 Forest Fire Disaster Identifier

\* 0942 Telescope Mode Monitor

\* 0943 Telescope Mode Recorder

\* 0944 Radar Data Quality Monitor

\* 0945 Sferics Detector Optics Cleaner

\* 0946 Sferics Detector Module Remover

\* 0947 Sferics Detector Module Installer

0948 Scatterometer Presentation Observer

0949 Scatterometer Mode Selector

0950 TV Camera Cap Installer



```
0951
         Camera Cap Installer
 0952
         Scanner Cap Installer
         Film Data Usefulness Determiner
 0953
         TV Data Usefulness Determiner
 0954
         Scanner Data Usefulness Determiner
 0955
 0956
         Scatterometer Usefulness Determiner
         Scanner Data Evaluator
 0957
 0958
         TV Data Evaluator
 0959
         Scatterometer Data Evaluator
 0960
         Scatterometer Optics Cleaner
 0961
         Scatterometer Module Remover
 0962
         Scatterometer Module Installer
 0963
         Telescope Cap Installer
 0964
         Spectrometer Cap Installer
 0965
         Radiometer Cap Installer
 0966
         Scatterometer Cap Installer
 0967
         Polarimeter Cap Installer
*0968
         Composite Materials Research Planner
         Composite Materials Data Recorder
*0969
 0970
         Composite Materials Structure Determiner
*0971
         Composite Materials Structure Analyzer
 0972
         Composite Materials Processing Observer
*0973
         Composite Materials Research Evaluator
*0974
         Composite Materials Sample Installer
*0975
         Composite Materials Sample Unstower
*0976
         Composite Materials Sample Translocator
*0977
         Composite Materials Sample Remover
*0978
         Composite Materials Sample Stower
         Furnace Deployer
 0979
*0980
         Furnace Unstower
*0981
         Furnace Module Remover
*0982
         Furnace Module Installer
         Furnace Stower
*0983
*0984
         Furnace Cleaner
         Furnace Operation Monitor
*0985
         Furnace Disassembler
 0986
         Furnace Assembler
 0987
*0988
         Furnace Repairer
* 0989
         Furnace Fault Identifier
         Mixing Unit Deployer
 0990
* 0991
         Mixing Unit Installer
* 0992
         Mixing Unit Unstower
* 0993
         Mixing Unit Translocator
* 0994
         Mixing Unit Remover
 0995
         Mixing Unit Module Remover
 0996
         Mixing Unit Module Installer
* 0997
         Mixing Unit Stower
* 0998
         Mixing Unit Cleaner
         Mixing Unit Operation Monitor
* 0999
 1000
         Mixing Unit Disassembler
```



#1001-1050

```
1001
         Mixing Unit Assembler
         Mixing Unit Repairer
*1002
         Mixing Unit Fault Identifier
*1003
 1004
         Mold Injection System Deployer
         Mold Injection System Unstower
 1005
         Mold Injection System Module Remover
 1006
         Mold Injection System Module Installer
 1007
 1008
         Mold Injection System Stower
 1009
         Mold Injection System Cleaner
 1010
         Mold Injection System Operation Monitor
 1011
         Mold Injection System Disassembler
 1012
         Mold Injection System Assembler
 1013
         Mold Injection System Repairer
 1014
         Mold Injection System Fault Identifier
 1015
         Materials Forming Equipment Deployer
*1016
         Materials Forming Equipment Installer
*1017
         Materials Forming Equipment Unstower
*1018
         Materials Forming Equipment Translocator
 1019
         Materials Forming Equipment Remover
 1020
         Materials Forming Equipment Stower
*1021
         Materials Forming Equipment Cleaner
 1022
         Liquid Metal Supply System Deployer
 1023
         Liquid Metal Supply System Unstower
 1024
         Liquid Metal Supply System Module Remover
 1025
         Liquid Metal Supply System Module Installer
 1026
         Liquid Metal Supply System Stower
 1027
         Liquid Metal Supply System Cleaner
 1028
         Liquid Metal Supply System Operation Monitor
         Liquid Metal Supply System Disassembler
 1029
 1030
         Liquid Metal Supply System Assembler
 1031
         Liquid Metal Supply System Repairer
 1032
         Liquid Metal Supply System Fault Identifier
         Materials Science C/D Equipment Deployer
 1033
 1034
         Materials Science C/D Equipment Module Remover
 1035
         Materials Science C/D Equipment Module Installer
 1036
         Materials Science C/D Equipment Disassembler
 1037
         Materials Science C/D Equipment Assembler
 1038
         Materials Science C/D Equipment Repairer
 1039
         Materials Science C/D Equipment Fault Identifier
 1040
         Materials Analysis Equipment Installer
 1041
         Materials Analysis Equipment Unstower
         Materials Analysis Equipment Translocator
 1042
         Materials Analysis Equipment Remover
 1043
         Materials Analysis Equipment Module Remover
 1044
         Materials Analysis Equipment Module Installer
 1045
         Materials Analysis Equipment Calibrator
*1046
         Materials Analysis Equipment Stower
 1047
         Materials Analysis Equipment Cleaner
*1048
         Materials Analysis Equipment Controller
*1049
 1050
         Materials Analysis Equipment Disassembler
```



```
Materials Analysis Equipment Assembler
 1051
 1052
         Materials Analysis Equipment Repairer
          Materials Analysis Equipment Fault Identifier
 1053
          Computer Unstower
*1054
          Computer Operation Monitor
*1055
          Computer Disassembler
 1056
          Computer Assembler
 1057
          Environmental Chamber Unstower
*1058
          Environmental Chamber Module Remover
* 1059
          Environmental Chamber Module Installer
* 1060
          Environmental Chamber Stower
* 1061
          Environmental Chamber Cleaner
*1062
          Environmental Chamber Disassembler
 1063
 1064
          Environmental Chamber Assembler
* 1065
          Environmental Chamber Repairer
          Environmental Chamber Fault Identifier
* 1066
          Chill System Installer
* 1067
* 1068
          Chill System Unstower
* 1069
          Chill System Translocator
* 1070
          Chill System Remover
 1071
         Chill System Module Remover
 1072
          Chill System Module Installer
* 1073
          Chill System Stower
* 1074
          Chill System Operation Monitor
 1075
         Chill System Disassembler
 1076
         Chill System Assembler
* 1077
          Chill System Repairer
* 1078
          Chill System Fault Identifier
* 1079
          Vibrator Installer
          Vibrator Unstower
* 1080
         Vibrator Translocator
* 1081
          Vibrator Remover
* 1082
          Vibrator Module Remover
 1083
 1084
          Vibrator Module Installer
* 1085
          Vibrator Stower
* 1086
          Vibrator Operation Monitor
          Vibrator Disassembler
 1087
          Vibrator Assemble:
 1088
* 1089
          Vibrator Repairer
* 1090
          Vibrator Fault Identifier
* 1091
          VHF Power Unit Installer
          VHF Power Unit Unstower
* 1092
          VHF Power Unit Translocator
* 1093
* 1094
          VHF Power Unit Remover
* 1095
          VHF Power Unit Module Remover
* 1096
          VHF Power Unit Module Installer
* 1097
          VHF Power Unit Calibrator
* 1098
          VHF Power Unit Stower
          VHF Power Unit Operation Monitor
* 1099
          VHF Power Unit Disassembler
 1100
```



```
VHF Power Unit Assembler
 1101
*1102
         VHF Power Unit Repairer
*1103
         VHF Power Unit Fault Identifier
*1104
         Telemetry Equipment Controller
*1105
         Dispersion Control System Unstower
 1106
         Dispersion Control System Module Remover
*1107
         Dispersion Control System Stower
         Dispersion Control System Module Installer
 1108
*1109
         Dispersion Control System Cleaner
*1110
         Dispersion Control System Operation Monitor
         Dispersion Control System Disassembler
 1111
 1112
         Dispersion Control System Assembler
*1113
         Dispersion Control System Repairer
*1114
         Dispersion Control System Fault Identifier
*1115
         Slip Cast Injection System Installer
*1116
         Slip Cast Injection System Unstower
*1117
         Slip Cast Injection System Translocator
*1118
         Slip Cast Injection System Remover
 1119
         Slip Cast Injection System Module Remover
 1120
         Slip Cast Injection System Module Installer
         Slip Cast Injection System Stower
 1121
*1122
         Slip Cast Injection System Operation Monitor
 1123
         Slip Cast Injection System Disassembler
 1124
         Slip Cast Injection System Assembler
*1125
         Slip Cast Injection System Repairer
*1126
         Slip Cast Injection System Fault Identifier
*1127
         Atmosphere Supply/Control System Module Remover
*1128
         Atmosphere Supply/Control System Module Installer
*1129
         Atmosphere Supply/Control System Operation Monitor
         Atmosphere Supply/Control System Disassembler
 1130
         Atmosphere Supply/Control System Assembler
 1131
* 1132
         Atmosphere Supply/Control System Repairer
* 1133
         Atmosphere Supply/Control System Fault Identifier
* 1134
         Power Conditioning/Distribution System Module Remover
* 1135
         Power Conditioning/Distribution System Module Installer
* 1136
         Power Conditioning/Distribution System Operation Monitor
         Power Conditioning/Distribution System Disassembler
 1137
         Power Conditioning/Distribution System Assembler
 1138
* 1139
         Power Conditioning/Distribution System Repairer
* 1140
         Power Conditioning/Distribution System Fault Identifier
* 1141
         Environmental Chamber Operation Monitor
* 1142
         Heat Rejection System Unstower
         Heat Rejection System Module Remover
 1143
         Heat Rejection System Module Installer
 1144
         Heat Rejection System Stower
* 1145
         Heat Rejection System Operation Monitor
* 1146
         Heat Rejection System Disassembler
 1147
 1148
         Heat Rejection System Assembler
* 1149
         Heat Rejection System Repairer
         Heat Rejection System Fault Identifier
* 1150
```

	•
1151	Internal Attachments Installer
1152	Internal Attachments Unstower
1153	Internal Attachments Translocator
1154	Internal Attachments Remover
1155	Internal Attachments Stower
*1156	Data Recorder Installer
1157	Data Recorder Controller
1158	Photograph Enlarger Controller
1159	Photograph Printer Controller
*1160	Computer Stower
1161	Materials Science C/D Equipment Unstower
*1162	Atmosphere Supply/Control System Unstower
*1163	Power Conditioning/Distribution System Unstower
1164	Metal Foam Sample Unstower
1165	Metal Foam Sample Translocator
1166	Metal Foam Sample Installer
1167	Metal Foam Sample Remover
1168	Materials Science C/D Equipment Stower
*1169	Atmosphere Supply/Control System Stower
<b>*</b> 1170	Power Conditioning/Distribution System Stower
1171	Metal Foam Sample Stower
1172	Materials Science C/D Equipment Control Actuator
*1173	Environmental Chamber Control Actuator
*1174	Atmosphere Supply/Control System Control Actuator
<b>*</b> 1175	Furnace Control Actuator
<b>*</b> 1176	Dispersion Control System Control Actuator
<b>*</b> 1177	Mixing Unit Control Actuator
1178	Liquid Metal Supply System Control Actuator
<b>*</b> 1179	Power Conditioning/Distribution System Control Actuator
1180	Mold Injection System Control Actuator
<b>*</b> 1181	Chill System Control Actuator
<b>*</b> 1182	Vibrator Control Actuator
<b>*</b> 1183	VHF Power Unit Control Actuator
<b>*</b> 1184	Heat Rejection System Control Actuator
1185	Metal Foam Structure Determiner
1186	Metal Foam Structure Analyzer
1187	Metal Foam Structure Evaluator
1188	Metal Foam Structure Test Report Preparer
1189	Metal Foam Research Planner
1190	Metal Foam Research Evaluator
1191	Workspace Equipment Unstower
1192	Workspace Equipment Stower
* 1193	Telescope Repairer
<b>*</b> 1194	TV System Repairer
<b>*</b> 1195	Camera Repairer
1196	Grating Repairer
1197	Band Filter Repairer
1198	Metal Free Casting Research Planner
1199	Metal Free Casting Test Report Preparer
1200	Metal Free Casting Structure Determiner
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1201	Metal Free Casting Structure Analyzer
1202	Metal Free Casting Research Evaluator
*1203	Atmosphere Analysis Unit Unstower
*1204	Atmosphere Analysis Unit Translocator
*1205	Atmosphere Analysis Unit Installer
*1206	Atmosphere Analysis Unit Remover
*1207	Atmosphere Analysis Unit Stower
*1208	Atmosphere Analysis Unit Module Remover
*1209	Atmosphere Analysis Unit Module Installer
<b>*</b> 1210	Atmosphere Analysis Unit Fault Identifier
<b>*</b> 1211	Atmosphere Analysis Unit Repairer
1212	Atmosphere Analysis Unit Disassembler
1213	Atmosphere Analysis Unit Assembler
*1214	Atmosphere Analysis Unit Control Actuator
*1215	Viewing Device Unstower
*1216	Viewing Device Translocator
*1217	Viewing Device Installer
*1218	Viewing Device Remover
*1219	Viewing Device Stower
1220	Viewing Device Module Remover
1221	Viewing Device Module Installer
*1222	Viewing Device Fault Identifier
<b>*</b> 1223	Viewing Device Repairer
1224	Viewing Device Disassembler
1225	Viewing Device Assembler
<b>*</b> 1226	Camera Translocator
*1227	Holographic Device Calibrator
<b>*</b> 1228	Holographic Device Operation Monitor
<b>*</b> 1229	Holographic Device Control Actuator
1230	Holographic Device Assembler
1231	Holographic Device Disassembler
*1232	Holographic Device Repairer
* 1233	Holographic Device Fault Identifier
<b>*</b> 1234	Holographic Device Module Installer
<b>*</b> 1235	Holographic Device Module Remover
<b>*</b> 1236	Holographic Device Stower
* 1237	Holographic Device Remover
<b>*</b> 1238	Holographic Device Installer
<b>*</b> 1239	Holographic Device Translocator
<b>*</b> 1240	Holographic Device Unstower
<b>*</b> 1241	Heating/Cooling Device Operation Monitor
* 1242	Heating/Cooling Device Control Actuator
1243	Heating/Cooling Device Assembler
1244	Heating/Cooling Device Disassembler
<b>*</b> 1245	Heating/Cooling Device Repairer
<b>*</b> 1246	Heating/Cooling Device Fault Identifier
1247	Heating/Cooling Device Module Installer
1248	Heating/Cooling Device Module Remover
1249	Heating/Cooling Device Stower
<b>*</b> 1250	Heating/Cooling Device Remover



```
*1251
         Heating/Cooling Device Installer
*1252
         Heating/Cooling Device Translocator
         Heating/Cooling Device Unstower
*1253
         Metal Sample Installer
*1254
*1255
         Metal Sample Remover
*1256
         Metal Sample Translocator
*1257
         Metal Sample Unstower
 1258
         Heating/Positioning Coil Controller
*1259
         Heating/Positioning Coil Operation Monitor
*1260
         Heating/Positioning Coil Control Actuator
 1261
         Heating/Positioning Coil Assembler
 1262
         Heating/Positioning Coil Disassembler
*1263
         Heating/Positioning Coil Repairer
*1264
         Heating/Positioning Coil Fault Identifier
 1265
         Heating/Positioning Coil Module Installer
 1266
         Heating/Positioning Coil Module Remover
*1267
         Heating/Positioning Coil Stower
*1268
         Heating/Positioning Coil Remover
*1269
         Heating/Positioning Coil Installer
*1270
         Heating/Positioning Coil Translocator
*1271
         Heating/Positioning Coil Unstower
 1272
         Plasma Beam Unit Operation Monitor
 1273
         Plasma Beam Unit Control Actuator
 1274
         Plasma Beam Unit Assembler
 1275
         Plasma Beam Unit Disassembler
 1276
         Plasma Beam Unit Repairer
         Plasma Beam Unit Fault Identifier
 1277
 1278
         Plasma Beam Unit Module Installer
 1279
         Plasma Beam Unit Module Remover
 1280
         Plasma Beam Unit Stower
 1281
         Plasma Beam Unit Remover
 1282
         Plasma Beam Unit Installer
 1283
         Plasma Beam Unit Translocator
 1284
         Plasma Beam Unit Unstower
 1285
         Liquid Sphere Deployment System Operation Observer
 1286
         Liquid Sphere Deployment System Controller
 1287
         Liquid Sphere Deployment System Operation Monitor
 1288
         Liquid Sphere Deployment System Control Actuator
 1289
         Liquid Sphere Deployment System Assembler
 1290
         Liquid Sphere Deployment System Disassembler
 1291
         Liquid Sphere Deployment System Repairer
 1292
         Liquid Sphere Deployment System Fault Identifier
 1293
         Liquid Sphere Deployment System Module Installer
 1294
         Liquid Sphere Deployment System Module Remover
 1295
         Liquid Sphere Deployment System Stower
 1296
         Liquid Sphere Deployment System Remover
 1297
         Liquid Sphere Deployment System Installer
 1298
         Liquid Sphere Deployment System Translocator
 1299
         Liquid Sphere Deployment System Unstower
 1300
         Hollow Bodies Deployment System Controller
```



#1301-1350

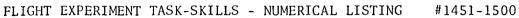
1301 Hollow Bodies Deployment System Operation Observer 1302 Hollow Bodies Deployment System Operation Monitor 1303 Hollow Bodies Deployment System Control Actuator 1304 Hollow Bodies Deployment System Assembler 1305 Hollow Bodies Deployment System Disassembler 1306 Hollow Bodies Deployment System Repairer Hollow Bodies Deployment System Fault Identifier 1307 Hollow Bodies Deployment System Module Installer 1308 1309 Hollow Bodies Deployment System Module Remover 1310 Hollow Bodies Deployment System Stower 1311 Hollow Bodies Deployment System Remover 1312 Hollow Bodies Deployment System Installer 1313 Hollow Bodies Deployment System Translocator 1314 Hollow Bodies Deployment System Unstower 1315 Membrane Drawing Tool Controller 1316 Membrane Drawing Tool Operation Observer 1317 Membrane Drawing Tool Operation Monitor 1318 Membrane Drawing Tool Control Actuator Membrane Drawing Tool Assembler 1319 1320 Membrane Drawing Tool Disassembler 1321 Membrane Drawing Tool Repairer Membrane Drawing Tool Fault Identifier 1322 1323 Membrane Drawing Tool Module Installer 1324 Membrane Drawing Tool Module Remover 1325 Membrane Drawing Tool Stower 1326 Membrane Drawing Tool Remover 1327 Membrane Drawing Tool Installer 1328 Membrane Drawing Tool Translocator Membrane Drawing Tool Unstower 1329 1330 Materials Science C/D Equipment Control Deactuator 1331 Heat Rejection System Remover 1332 Heat Rejection System Installer \*1333 Heating/Positioning Coil Calibrator 1334 Plasma Beam Unit Calibrator Membrane Drawing Tool Calibrator 1335 \*1336 Heating/Positioning Coil Cleaner 1337 Plasma Beam Unit Cleaner Liquid Sphere Deployment System Cleaner 1338 1339 Hollow Bodies Deployment System Cleaner 1340 Membrane Drawing Tool Cleaner \*1341 Metal Sample Stower Heating/Positioning Coil Operation Observer 1342 \*1343 Atmosphere Analysis Unit Operation Monitor \*1344 Camera Operation Monitor \*1345 TV Camera Operation Monitor Liquid Dispersion Research Planner \*1346 \*1347 Slip Formulation Controller \*1348 Slip Materials Stower Materials Slip Mixing Controller 1349 1350 Materials Slip Mold Opener

#1351-1400

\*1351 Slip Materials Remover Materials Slip Drying Observer 1352 \*1353 Liquid Dispersion Research Evaluator \*1354 Materials Sample Unstower \*1355 Materials Sample Translocator \*1356 Materials Sample Installer \*1357 Materials Sample Remover \*1358 Slip Casting Remover \*1359 Slip Casting Stower Immiscible System Casting Stower \*1360 \*1361 Slip Cast Injection System Cleaner **\***1362 Immiscible System Casting Remover \*1363 Slip Cast Injection System Controller 1364 Mold Injection System Controller 1365 Immiscible System Dispersion Determiner \*1366 Sample Holder Installer \*1367 Crystal Growth Research Planner \*1368 Crystal Growth Observer \*1369 Crystal Growth Process Evaluator · \*1370 Materials Dopant Installer \*1371 Materials Sample Stower \*1372 Silicate Melt Susceptor Control Actuator \*1373 Silicate Melt Susceptor Unstower **\***1374 Silicate Melt Susceptor Translocator **\***1375 Silicate Melt Susceptor Installer \*1376 Silicate Melt Susceptor Remover **\***1377 Silicate Melt Susceptor Module Remover \*1378 Silicate Melt Susceptor Module Installer 1379 Silicate Melt Susceptor Cleaner 1380 Seed Injector Control Actuator 1381 Seed Injector Unstower 1382 Seed Injector Translocator 1383 Seed Injector Installer 1384 Seed Injector Remover 1385 Seed Injector Module Remover 1386 Seed Injector Module Installer 1387 Seed Injector Cleaner 1388 Seed Injector Operation Monitor Seed Injector Disassembler 1389 1390 Seed Injector Assembler 1391 Seed Injector Fault Identifier 1392 Seed Injector Repairer 1393 Teleoperator System Repairer \*1394 Crystal Growth Research Evaluator \* 1395 Silicate Melt Susceptor Fault Identifier **\*** 1396 Silicate Melt Susceptor Repairer SITOS Fault Identifier 1397 \*1398 Silicate Solvent Applier Data Recorder Control Actuator 1399 **\*** 1400 Furnace Control Deactuator

#1401-1450

\*1401 Silicate Melt Susceptor Operation Monitor Silicate Melt Susceptor Disassembler 1402 Silicate Melt Susceptor Assembler 1403 SITOS Repairer 1404 Zone Melter Control Actuator \*1405 Zone Melter Unstower \*1406 Zone Melter Translocator \*1407 Zone Melter Installer \*1408 1409 Zone Melter Remover Zone Melter Module Remover \*1410 \*1411 Zone Melter Module Installer \*1412 Zone Melter Cleaner \*1413 Zone Melter Operation Monitor 1414 Zone Melter Disassembler **\***1415 Crystal Puller Control Actuator \*1416 Crystal Puller Unstower \*1417 Crystal Puller Translocator **\***1418 Crystal Puller Installer \*1419 Crystal Puller Remover 1420 Crystal Puller Module Remover 1421 Crystal Puller Module Installer **\***1422 Crystal Puller Cleaner \*1423 Crystal Puller Operation Monitor Crystal Puller Disassembler 1424 \*1425 Zone Refiner Control Actuator \*1426 Zone Refiner Unstower \*1427 Zone Refiner Translocator **\***1428 Zone Refiner Installer Zone Refiner Remover 1429 Zone Refiner Module Remover \*1430 \*1431 Zone Refiner Module Installer Zone Refiner Cleaner \*1432 Zone Refiner Operation Monitor \*1433 Zone Refiner Disassembler 1434 1435 Zone Refiner Assembler \*1436 Zone Refiner Fault Identifier \*1437 Zone Refiner Repairer 1438 Zone Melter Assembler Zone Melter Fault Identifier \*1439 Zone Melter Repairer \*1440 Crystal Puller Assembler 1441 \*1442 Crystal Puller Fault Identifier \*1443 Crystal Puller Repairer \*1444 Crystal Growth Characteristics Determiner \*1445 Crystal Growth Structure Analyzer \*1446 Test Cell Installer \*1447 Materials Analysis Equipment Tester \*1448 Camera Tester \*1449 Holographic Device Tester 1450 Holographic Device Controller





1451	Camera Timer Control Actuator
1452	Camera Timer Disassembler
1453	Crystal Growth Structure Evaluator
*1454	Crystal Growth Data Recorder
*1455	Densitometer Unstower
*1456	Densitometer Translocator
*1457	Densitometer Installer
*1458	Densitometer Remover
1459	Densitometer Module Remover
1460	Densitometer Module Installer
*1461	Densitometer Calibrator
*1462	Densitometer Operation Monitor
1463	Densitometer Disassembler
1464	Densitometer Assembler
*1465	Densitometer Fault Identifier
<b>*</b> 1466	Densitometer Repairer
1467	Growth Tube Remover
1468	Growth Tube Controller
1469	Camera Timer Assembler
1470	Camera Timer Module Remover
1471	Camera Timer Module Installer
1472	Camera Timer Fault Identifier
1473	Camera Timer Repairer
*1474	Calorimeter Repairer
1475	Calorimeter Assembler
1476	Calorimeter Disassembler
1477	Calorimeter Module Installer
1478	Calorimeter Module Remover
*1479	Calorimeter Remover
<b>*</b> 1480	Calorimeter Installer
*1481	Calorimeter Translocator
<b>*</b> 1482	Calorimeter Unstower
<b>*</b> 1483	Friction Measuring Device Repairer
<b>*</b> 1484	Friction Measuring Device Fault Identifier
1485	Friction Measuring Device Assembler
1486	Friction Measuring Device Disassembler
<b>*</b> 1487	Friction Measuring Device Operation Monitor
<b>*</b> 1488	Friction Measuring Device Calibrator
1489	Friction Measuring Device Module Installer
1490	Friction Measuring Device Module Remover
<b>*</b> 1491	Friction Measuring Device Remover
<b>*</b> 1492	Friction Measuring Device Installer
<b>*</b> 1493	Friction Measuring Device Translocator
<b>*</b> 1494	Friction Measuring Device Unstower
<b>*</b> 1495	Friction Measuring Device Control Deactuator
<b>*</b> 1496	Friction Measuring Device Control Actuator
<b>*</b> 1497	Friction Measuring Device Stower
<b>*</b> 1498	Friction Measuring Device Cleaner
<b>*</b> 1499	Calorimeter Stower
* 1500	Calorimeter Cleaner
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#1501-1550

Materials Science C/D Equipment Operation Monitor 1501 Atmosphere Supply/Control System Control Deactuator 1502 Environmental Chamber Control Deactuator 1503 1504 Power Conditioning/Distribution System Control Deactuator \*1505 Heating/Positioning Coil Control Deactuator 1506 Zone Melter Control Deactuator \*1507 Atmosphere Analysis Unit Control Deactuator \*1508 Holographic Device Control Deactuator \*1509 VHF Power Unit Control Deactuator 1510 Heat Rejection System Control Deactuator 1511 Zone Melter Stower \*1512 Crystal Growth Process Monitor \*1513 Glass Samples Unstower \*1514 Glass Samples Translocator \*1515 Glass Samples Installer \*1516 Glass Samples Remover \*1517 Glass Samples Stower \*1518 Glass Structure Analyzer \*1519 Data Recorder Unstower Data Recorder Translocator \*1520 \*1521 Glass Processing Research Planner \*1522 Glass Processing Research Evaluator 1523 Glass Samples Observer \*1524 Gas Elimination/Cooling System Installer \*1525 Gas Elimination/Cooling System Unstower \*1526 Gas Elimination/Cooling System Translocator \*1527 Gas Elimination/Cooling System Cleaner \*1528 Gas Elimination/Cooling System Stower \*1529 Gas Elimination/Cooling System Operation Monitor 1530 Gas Elimination/Cooling System Disassembler 1531 Gas Elimination/Cooling System Assembler 1532 Gas Elimination/Cooling System Module Remover 1533 Gas Elimination/Cooling System Module Installer \*1534 Gas Elimination/Cooling System Fault Identifier \*1535 Gas Elimination/Cooling System Repairer \*1536 Cleanup/Refurbishment Equipment Installer \*1537 Cleanup/Refurbishment Equipment Unstower \*1538 Cleanup/Refurbishment Equipment Translocator \*1539 Cleanup/Refurbishment Equipment Stower \*1540 Buffer/Waste Separator Installer Buffer/Waste Separator Unstower \*1541 Buffer/Waste Separator Translocator \*1542 \*1543 Buffer/Waste Separator Cleaner \*1544 Buffer/Waste Separator Stower \* 1545 Buffer/Waste Separator Operation Monitor 1546 Buffer/Waste Separator Disassembler 1547 Buffer/Waste Separator Assembler **\*** 1548 Buffer/Waste Separator Fault Identifier \* 1549 TV System Control Actuator \* 1550 Data Compression Equipment Control Actuator

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Buffer Solution Installer
*1551
          Buffer Solution Unstower
*1552
          Buffer Solution Translocator
*1553
          Buffer Solution Remover
*1554
*1555
          Buffer Solution Mixing Controller
*1556
          Biological Materials Installer
*1557
          Biological Materials Unstower
*1558
          Biological Materials Translocator
*1559
          Biological Materials Remover
*1560
          Biological Enclosure Unstower
 1561
          Biological Enclosure Cleaner
*1562
          Biological Enclosure Stower
*1563
          Biological Enclosure Operation Monitor
 1564
          Biological Enclosure Disassembler
          Biological Enclosure Assembler
 1565
 1566
          Biological Enclosure Module Remover
 1567
          Biological Enclosure Module Installer
*1568
          Biological Enclosure Fault Identifier
*1569
          Biological Enclosure Repairer
 1570
          Buffer/Waste Separator Module Remover
 1571
          Buffer/Waste Separator Module Installer
*1572
          Buffer/Waste Separator Repairer
*1573
          Electrophoretic Column Installer
*1574
          Electrophoretic Column Unstower
* 1575
         Electrophoretic Column Translocator
*1576
          Electrophoretic Column Remover
* 1577
          Electrophoretic Column Cleaner
* 1578
          Electrophoretic Column Stower
* 1579
          Electrophoretic Column Operation Monitor
 1580
          Electrophoretic Column Disassembler
 1581
          Electrophoretic Column Assembler
 1582
          Electrophoretic Column Module Remover
 1583
          Electrophoretic Column Module Installer
* 1584
          Electrophoretic Column Fault Identifier
          Electrophoretic Column Repairer
* 1585
* 1586
          Electrophoretic Separation Research Planner
* 1587
          Electrophoretic Separation Process Evaluator
* 1588
          Electrophoretic Separation Data Recorder
* 1589
          Lyophilization Apparatus Control Actuator
 1590
          Lyophilization Apparatus Operation Monitor
 1591
          Lyophilization Apparatus Disassembler
 1592
          Lyophilization Apparatus Assembler
 1593
          Lyophilization Apparatus Module Remover
 1594
          Lyophilization Apparatus Module Installer
 1595
          Lyophilization Apparatus Fault Identifier
 1596
          Lyophilization Apparatus Repairer
 1597
          Syringe Controller
* 1598
          Ampoule Installer
          Data Recorder Remover
 1599
          Data Recorder Stower
 1600
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*1601	Interferometer Installer
*1602	Interferometer Unstower
*1603	Interferometer Translocator
*1604	Interferometer Remover
*1605	Interferometer Calibrator
*1606	Interferometer Tester
*1607	Interferometer Stower
*1608	Interferometer Controller
*1609	Interferometer Operation Monitor
1610	Interferometer Disassembler
1611	Interferometer Assembler
1612	Interferometer Module Remover
1613	Interferometer Module Installer
*1614	Interferometer Fault Identifier
*1615	Interferometer Repairer
*1616	Interferometer Control Actuator
*1617	Densitometer Control Actuator
*1618	Densitometer Tester
*1619	Densitometer Stower
*1620	Densitometer Controller
*1621	Buffer/Waste Separator Remover
*1622	Gas Elimination/Cooling System Remover
*1623	Buffer Solution Flow Rate Determiner
*1623	Biological Materials Test Observer
*1625	Electrophoretic Separation Research Evaluator
*1626	Biological Materials Mixing Controller
1627	Lyophilization Apparatus Unstower
1628	Lyophilization Apparatus Translocator
1629	Lyophilization Apparatus Installer
1630	Lyophilization Apparatus Remover
1631	Lyophilization Data Recorder
1632	Lyophilization Research Planner
1633	Biological Materials Culturing Controller
1634	Isotope Tracer-Counter Unstower
1635	Isotope Tracer-Counter Translocator
1636	Isotope Tracer-Counter Installer
1637	Isotope Tracer-Counter Remover
1638	Isotope Tracer-Counter Module Remover
1639	Isotope Tracer-Counter Module Installer
1640	Isotope Tracer-Counter Calibrator
1641	Isotope Tracer-Counter Operation Monitor
1642	Isotope Tracer-Counter Controller
1643	Isotope Tracer-Counter Disassembler
1644	Isotope Tracer-Counter Assembler
1645	Isotope Tracer-Counter Fault Identifier
1646	•
* 1647	Isotope Tracer-Counter Repairer Fluid Sample Mixing Controller
*1647 *1648	Fluid Convection Research Planner
*1648 *1649	Fluid Convection Research Flanner Fluid Convection Research Evaluator
*1650	
1030	Fluid Samples Installer



	D1 11 G 1 D
*1651	Fluid Samples Translocator
*1652	Fluid Samples Unstower
*1653	Fluid Samples Remover
1654	Rotational Testing Device Unstower
1655	Rotational Testing Device Translocator
1656	Rotational Testing Device Assembler
1657	Rotational Testing Device Installer
1658	Rotational Testing Device Tester
1659	Rotational Testing Device Remover
1660	Rotational Testing Device Module Remover
1661	Rotational Testing Device Module Installer
1662	Rotational Testing Device Cleaner
1663	Rotational Testing Device Stower
1664	Rotational Testing Device Control Actuator
1665	Rotational Testing Device Occupant
1666	Rotational Testing Device Controller
1667	Rotational Testing Device Calibrator
1668	Rotational Testing Device Disassembler
1669	Rotational Testing Device Fault Identifier
1670	Rotational Testing Device Repairer
1671	Protective Cover Remover
1672	Protective Cover Translocator
1673	Protective Cover Stower
1674	Protective Cover Unstower
1675	Protective Cover Installer
1676	Biteboard Unstower
1677	Biteboard Translocator
1678	Biteboard Installer
1679	Biteboard Remover
1680	Biteboard Cleaner
1681	Biteboard Stower
1682	
1683	
1684	
1685	Cable Remover
1686	Accelerometer Unstower
1687	Accelerometer Translocator
1688	Accelerometer Installer
1689	Accelerometer Tester
1690	Accelerometer Remover
1691	Accelerometer Cleaner
1692	Accelerometer Stower
1693	Accelerometer Fault Identifier
1694	Accelerometer Repairer
1695	Cable Tester
1696	Data Recorder Tester
1697	Data Recorder Disassembler
1698	Data Recorder Assembler
1699	Data Recorder Module Remover
1700	Data Recorder Module Installer

Life Sciences C/D Equipment Unstower 1701 Life Sciences C/D Equipment Tester 1702 Life Sciences C/D Equipment Module Remover 1703 1704 Life Sciences C/D Equipment Module Installer Life Sciences C/D Equipment Cleaner 1705 1706 Life Sciences C/D Equipment Stower 1707 Life Sciences C/D Equipment Fault Identifier Life Sciences C/D Equipment Repairer 1708 1709 Record Keeping Materials Unstower 1710 Record Keeping Materials Translocator Record Keeping Materials Stower 1711 1712 Head Proximity Device Unstower 1713 Head Proximity Device Translocator 1714 Head Proximity Device Installer 1715 Head Proximity Device Tester Head Proximity Device Remover 1716 1717 Head Proximity Device Module Remover 1718 Head Proximity Device Module Installer 1719 Head Proximity Device Cleaner 1720 Head Proximity Device Stower 1721 Head Proximity Device Disassembler 1722 Head Proximity Device Assembler 1723 Head Proximity Device Fault Identifier 1724 Head Proximity Device Repairer 1725 Vestibular Research Configuration Observer 1726 Vestibular Research Configuration Recorder 1727 Vestibular Research Data Recorder 1728 Vestibular Research Evaluator 1729 Vestibular Research Results Determiner 1730 Vestibular Research Planner 1731 Vestibular Research Observer 1732 Vestibular Research Results Communicator 1733 Data Management Unit Tester 1734 Data Management Unit Disassembler 1735 Data Management Unit Assembler 1736 Data Management Unit Module Remover 1737 Data Management Unit Module Installer 1738 Data Management Unit Fault Identifier 1739 Data Management Unit Repairer 1740 Human Subject Status Observer 1741 Human Subject Status Monitor RAM Surfaces Cleaner 1742 1743 RAM Facility Equipment Cleaner 1744 Visual Target Observer 1745 Visual Target Evaluator 1746 Visual Target Status Communicator 1747 Canal Stimulation Symptoms Evaluator 1748 Canal Stimulation Symptoms Communicator 1749 Spatial Localization Success Evaluator 1750 Plethysmograph Installer

1751	Plethysmograph Wearer					
1752	Plethysmograph Unstower					
1753	Plethysmograph Tester					
1754	Plethysmograph Remover					
1755	Plethysmograph Translocator					
1756	Plethysmograph Stower					
1757	Plethysmograph Operation Monitor					
1758	Plethysmograph Disassembler					
1759	Plethysmograph Assembler					
1760	Plethysmograph Module Remover					
1761	Plethysmograph Module Installer					
1762	Plethysmograph Fault Identifier					
1763	Plethysmograph Repairer					
1764	Sphygmomanometer Installer					
1765	Sphygmomanometer Wearer					
1766	Sphygmomanometer Unstower					
1767	Sphygmomanometer Translocator					
1768	Sphygmomanometer Tester					
1769	Sphygmomanometer Remover					
1770	Sphygmomanometer Stower					
1771	Sphygmomanometer Operation Monitor					
1772	Sphygmomanometer Disassembler					
1773	Sphygmomanometer Assembler					
1774	Sphygmomanometer Module Remover					
1775	Sphygmomanometer Module Installer					
1776	Sphygmomanometer Fault Identifier					
1777	Sphygmomanometer Repairer					
1778	Electrocardiograph Installer					
1779	Electrocardiograph Wearer					
1780	Electrocardiograph Unstower					
.1781	Electrocardiograph Translocator					
1782	Electrocardiograph Tester					
1783	Electrocardiograph Remover					
1784	Electrocardiograph Stower					
1785	Electrocardiograph Operation Monitor					
1786	Electrocardiograph Disassembler					
1787	Electrocardiograph Assembler					
1788	Electrocardiograph Module Remover					
1789	Electrocardiograph Module Installer					
1790	Electrocardiograph Fault Identifier					
1791	Electrocardiograph Repairer					
1792	LBNP Device Installer					
1793	LBNP Device Wearer					
1794	LBNP Device Unstower					
1795	LBNP Device Translocator					
1796	LBNP Device Tester					
1797	LBNP Device Remover					
1798	LBNP Device Stower					
1799	LBNP Device Control Actuator					
1800	LBNP Device Operation Monitor					
	<b>.</b>					



FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING #1801-1850 LBNP Device Disassembler 1801 1802 LBNP Device Assembler 1803 LBNP Device Module Remover 1804 LBNP Device Module Installer 1805 LBNP Device Fault Identifier 1806 LBNP Device Repairer 1807 Body Temperature Measuring Device Installer 1808 Body Temperature Measuring Device Wearer 1809 Body Temperature Measuring Device Unstower Body Temperature Measuring Device Translocator 1810 Body Temperature Measuring Device Tester 1811 1812 Body Temperature Measuring Device Remover 1813 Body Temperature Measuring Device Stower 1814 Body Temperature Measuring Device Operation Monitor 1815 Body Temperature Measuring Device Disassembler 1816 Body Temperature Measuring Device Assembler 1817 Body Temperature Measuring Device Module Remover 1818 Body Temperature Measuring Device Module Installer 1819 Body Temperature Measuring Device Fault Identifier 1820 Body Temperature Measuring Device Repairer 1821 Stowage Container Unstower 1822 Stowage Container Translocator 1823 Stowage Container Installer 1824 Stowage Container Remover 1825 Stowage Container Stower 1826 Life Sciences C/D Equipment Operation Monitor 1827 Cardioangiology Research Data Recorder 1828 Cardioangiology Research Planner 1829 Data Management Unit Control Actuator 1830 Cleaning/Decontamination Equipment Remover 1831 Electroanalytical System Cleaner 1832 Electroanalytical System Unstower 1833 Electroanalytical System Translocator 1834 Electroanalytical System Installer 1835 Electroanalytical System Tester Electroanalytical System Remover 1836 1837 Electroanalytical System Module Remover Electroanalytical System Module Installer 1838 1839 Electroanalytical System Stower 1840 Electroanalytical System Control Actuator 1841 Electroanalytical System Disassembler Electroanalytical System Assembler 1842

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Electroanalytical System Fault Identifier 1843 Electroanalytical System Repairer 1844 Biomedical Fluid Transfer Equipment Cleaner 1845 Biomedical Fluid Transfer Equipment Unstower 1846 Biomedical Fluid Transfer Equipment Translocator 1847 Biomedical Fluid Transfer Equipment Installer 1848 Biomedical Fluid Transfer Equipment Remover 1849 Biomedical Fluid Transfer Equipment Stower 1850



Photometer Cleaner 1851 Photometer Tester 1852 Photometer Remover 1853 Photometer Disassembler 1854 1855 Photometer Assembler Photometer Fault Identifier 1856 1857 Photometer Repairer 1858 Refractometer Cleaner 1859 Refractometer Unstower 1860 Refractometer Translocator 1861 Refractometer Installer 1862 Refractometer Tester Refractometer Remover 1863 1864 Refractometer Module Remover 1865 Refractometer Module Installer Refractometer Stower 1866 1867 Refractometer Control Actuator 1868 Refractometer Disassembler 1869 Refractometer Assembler 1870 Refractometer Fault Identifier 1871 Refractometer Repairer 1872 Centrifuge Cleaner 1873 Centrifuge Unstower 1874 Centrifuge Translocator 1875 Centrifuge Installer 1876 Centrifuge Tester 1877 Centrifuge Remover 1878 Centrifuge Module Remover 1879 Centrifuge Module Installer 1880 Centrifuge Stower 1881 Centrifuge Disassembler 1882 Centrifuge Assembler 1883 Centrifuge Fault Identifier 1884 Centrifuge Repairer 1885 Waste Management System Cleaner Waste Management System Unstower 1886 1887 Waste Management System Tester 1888 Waste Management System Module Remover 1889 Waste Management System Module Installer 1890 Waste Management System Stower 1891 Waste Management System Disassembler 1892 Waste Management System Assembler 1893 Waste Management System Fault Identifier 1894 Waste Management System Repairer 1895 Syringe Unstower 1896 Syringe Translocator 1897 Syringe Installer 1898 Syringe Stower 1899 Biological Sample Container Unstower Biological Sample Container Translocator 1900

Biological Sample Container Installer 1901 1902 Biological Sample Container Stower Freezer Unstower 1903 Freezer Tester 1904 Freezer Stower 1905 1906 Freezer Disassembler Freezer Assembler 1907 Freezer Module Remover 1908 1909 Freezer Module Installer 1910 Freezer Fault Identifier 1911 Freezer Repairer 1912 Timing Device Remover 1913 Timing Device Installer 1914 Timing Device Module Remover 1915 Timing Device Module Installer 1916 Timing Device Translocator 1917 Timing Device Stower 1918 Timing Device Unstower 1919 Timing Device Observer 1920 Timing Device Disassembler Timing Device Assembler 1921 1922 Timing Device Fault Identifier 1923 Timing Device Repairer 1924 Timing Device Tester 1925 Body Waste Stower 1926 Body Waste Sample Remover 1927 Body Waste Sample Translocator 1928 Body Waste Sample Stower Body Waste Controller 1929 1930 Body Waste Measurement Observer 1931 Body Waste Measurement Recorder Body Waste Sample Installer 1932 1933 . Gauze Sponge Stower 1934 Urology Research Data Recorder 1935 Urology Research Data Processor 1936 Urology Research Planner 1937 Record Keeping Materials Remover Blood Sample Remover 1938 1939 Blood Sample Translocator 1940 Blood Sample Stower 1941 Blood Sample Donor 1942 Blood Sample Installer 1943 Blood Sample Measurement Observer 1944 Blood Sample Measurement Recorder 1945 Waste Management System Control Actuator 1946 Human Subject Injection Site Determiner 1947 Human Subject Withdrawal Site Determiner 1948 PAH Injection Receiver 1949 Urology Research Schedule Communicator 1950

Electrocardiograph Control Actuator



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1951
         Ergometer Control Actuator
 1952
         Ergometer Unstower
         Ergometer Translocator
 1953
         Ergometer Installer
 1954
         Ergometer Tester
 1955
 1956
         Ergometer Control Deactuator
         Ergometer Remover
 1957
 1958
         Ergometer Stower
         Ergometer Controller
 1959
         Ergometer Disassembler
 1960
         Ergometer Assembler
 1961
 1962
         Ergometer Module Remover
 1963
         Ergometer Module Installer
 1964
         Ergometer Fault Identifier
 1965
         Ergometer Repairer
 1966
         Life Sciences C/D Equipment Control Deactuator
         Life Sciences C/D Equipment Control Actuator
 1967
 1968
         Cardiotachometer Unstower
 1969
         Cardiotachometer Translocator
         Cardiotachometer Installer
 1970
         Cardiotachometer Tester
 1971
         Cardiotachometer Remover
 1972
 1973
         Cardiotachometer Stower
 1974
         Cardiotachometer Control Actuator
 1975
         Cardiotachometer Disassembler
 1976
         Cardiotachometer Assembler
 1977
         Cardiotachometer Module Remover
 1978
         Cardiotachometer Module Installer
         Cardiotachometer Fault Identifier
 1979
 1980
         Cardiotachometer Repairer
 1981
         Timing Device Control Actuator
 1982
         Exercise Conditioning Research Planner
 1983
         Exercise Conditioning Research Instruction Communicator
 1984
         Exercise Conditioning Research Data Recorder
 1985
         Human Subject Heart Rate Monitor
*1986
         Atmosphere Supply/Control System Inspector
         Atmosphere Supply/Control System Tester
*1987
 1988
         Atmosphere Supply/Control System Installer
 1989
         Atmosphere Supply/Control Research Data Communicator
 1990
         Atmosphere Supply/Control System Remover
 1991
         Atmosphere Supply/Control System Translocator
 1992
         Atmosphere Supply/Control Sample Stower
 1993
         Atmosphere Supply/Control Research Data Recorder
 1994
         Atmosphere Supply/Control System Problem Determiner
 1995
         Data Management Unit Operation Monitor
 1996
         EVA Suit Unstower
 1997
         EVA Suit Inspector
 1998
         EVA Suit Installer
 1999
         EVA Suit Umbilical Connector
 2000
         EVA Suit Cable Connector
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#2001-2050

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2001
          EVA Suit Tester
  2002
          EVA Suit Remover
  2003
          EVA-Vehicle Intercom Communicator
          EVA Test Assembly Calibrator
  2004
  2005
          EVA Test Assembly Controller
  2006
          EVA Test Assembly Control Actuator
          EVA Test Assembly Control Deactuator
  2007
          EVA Test Assembly Cleaner
  2008
  2009
          EVA Test Assembly Assembler
          EVA Test Assembly Disassembler
  2010
  2011
          EVA Test Assembly Translocator
  2012
          EVA Test Assembly Module Remover
  2013
          EVA Test Assembly Module Installer
          EVA Test Assembly Remover
  2014
  2015
          EVA Test Assembly Installer
  2016
          EVA Suit Operating Status Monitor
          EVA Suit Research Debriefing Communicator
  2017
  2018
          EVA Suit Research Data Evaluator
          EVA Suit Cleaner
  2019
          EVA Suit Module Remover
  2020
  2021
          EVA Suit Module Installer
  2022
          EVA Suit Fault Identifier
  2023
          EVA Suit Repairer
  2024
          Biomedical Measurements Sensor Installer
  2025
          Biopack Unstower
          Biopack Installer
  2026
  2027
          Biopack Tester
  2028
          Biopack Remover
  2029
          Biopack Operating Status Monitor
  2030
          Biopack Research Debriefing Communicator
  2031
          Biopack Research Data Evaluator
  2032
          Biopack Cleaner
  2033
          Biopack Disassembler
  2034
          Biopack Assembler
  2035
          Biopack Module Remover
  2036
          Biopack Module Installer
  2037
          Biopack Fault Identifier
  2038
          Biopack Repairer
  2039
          Tether/Control Unit Control Actuator
  2040
          Spectrograph Remover
  2041
          Spectrograph Installer
  2042
          Comm/Nav C/D Equipment Self-Test Control Actuator
  2043
          Comm/Nav C/D Equipment Self-Test Display Monitor
  2044
          Lyophilization Research Evaluator
* 2045
          TV Camera Mode Recorder
* 2046
          Scanner Mode Recorder
* 2047
          Radiometer Mode Recorder
* 2048
          Polarimeter Mode Recorder
* 2049
          Spectrometer Mode Recorder
* 2050
          Camera Status Monitor
```



\* 2100

# FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#2051-2100

\*2051 Time Elapsed Observer \*2052 TV Camera Status Monitor \*2053 Atmospheric Pollution Data Observer \*2054 Water Pollution Data Observer \*2055 Water Pollution Data Evaluator \*2056 Atmospheric Pollution Data Evaluator Meteorological Conditions Evaluator \*2057 \*2058 Mission Events Evaluator \* 2059 TV System Inspector \* 2060 TV System Tester \* 2061 Scanner Tester \* 2062 Polarimeter Tester \* 2063 Polarimeter Aligner \* 2064 TV System Fault Identifier \* 2065 Earth Survey C/D Equipment Repairer \* 2066 Scanner Repairer \* 2067 Polarimeter Repairer \* 2068 TV System Control Deactuator 2069 Not Assigned 2070 Not Assigned 2071 Not Assigned 2072 Not Assigned 2073 Not Assigned 2074 Not Assigned 2075 Not Assigned \* 2076 TV Data Classifier Scanner Data Classifier \* 2077 \* 2078 Radiometer Data Classifier \* 2079 Polarimeter Data Classifier \* 2080 Spectrometer Data Classifier \* 2081 Polarimeter Controller \* 2082 TV Data Analyzer Scanner Data Analyzer \* 2083 \* 2084 Radiometer Data Analyzer \* 2085 Polarimeter Data Analyzer \* 2086 Spectrometer Data Analyzer \* 2087 Telescope Data Analyzer \* 2088 Scanner Adequacy Determiner \* 2089 TV Camera Adequacy Determiner \* 2090 Radiometer Adequacy Determiner \* 2091 Polarimeter Adequacy Determiner \* 2092 Telescope Adequacy Determiner \* 2093 Camera Adequacy Determiner \* 2094 TV System Operation Monitor \* 2095 Scanner Operation Monitor \* 2096 Radiometer Operation Monitor \* 2097 Polarimeter Operation Monitor \* 2098 Spectrometer Operation Monitor \* 2099 Telescope Operation Monitor

FLIGHT	EXPERIMENT	TASK-SKILLS	-	NUMERICAL	LISTING	#2101-2150

**\*** 2101 Water Pollution Data Classifier **\*** 2102 Video Data Quality Evaluator \* 2103 Radar Transmitter Mode Monitor \* 2104 Radar Receiver Mode Monitor \* 2105 Radar Transmitter Mode Recorder \* 2106 Radar Receiver Mode Recorder \* 2107 Land Use Data Observer \* 2108 Land Use Data Evaluator \* 2109 Radar Data Classifier \* 2110 Telescope Data Classifier \* 2111 Spectrometer Adequacy Determiner \* 2112 Radar Transmitter Adequacy Determiner \* 2113 Radar Receiver Adequacy Determiner \* 2114 Radar Operation Monitor \* 2115 Land Use Data Classifier Earth Surface Landmark Observer \* 2116 Earth Surface Landmark Classifier \* 2117 Sferics Detector Mode Monitor \* 2118 \* 2119 Sferics Detector Mode Recorder \* 2120 Camera Mode Recorder \* 2121 Geological Precursor Data Observer \* 2122 Geological Precursor Data Evaluator \* 2123 Earthquake Data Observer \* 2124 Earthquake Data Evaluator \* 2125 Sferics Detector Tester \* 2126 Telescope Tester \* 2127 Sferics Detector Adequacy Determiner \* 2128 Meteorological Precursor Data Observer \* 2129 Artificial Precursor Data Observer \* 2130 Topographical Precursor Data Observer \* 2131 Precursor Disaster Data Observer \* 2132 Meteorological Precursor Data Evaluator \* 2133 Artificial Precursor Data Evaluator \* 2134 Topographical Precursor Data Evaluator \* 2135 Precursor Disaster Data Evaluator \* 2136 Hurricane Data Observer \* 2137 Tornado Data Observer \* 2138 Tidal Wave Data Observer \* 2139 Flood Data Observer \* 2140 Volcanic Eruption Data Observer Forest Fire Data Observer \* 2141 Range Fire Data Observer \* 2142 \* 2143 Landslide Data Observer \* 2144 Snowslide Data Observer \* 2145 Land Subsidence Data Observer \* 2146 Drought Data Observer Blizzard Data Observer \* 2147 \* 2148 Hurricane Data Evaluator \* 2149 Tornado Data Evaluator \* 2150 Tidal Wave Data Evaluator

#2151-2200

\* 2151 Flood Data Evaluator \* 2152 Volcanic Eruption Data Evaluator \* 2153 Forest Fire Data Evaluator \* 2154 Range Fire Data Evaluator \* 2155 Landslide Data Evaluator \* 2156 Snowslide Data Evaluator \* 2157 Land Subsidence Data Evaluator \* 2158 Drought Data Evaluator \* 2159 Blizzard Data Evaluator \* 2160 Geological Precursor Observer \* 2161 Meteorological Precursor Observer \* 2162 Artificial Precursor Observer \* 2163 Topographical Precursor Observer \* 2164 Precursor Disaster Observer \* 2165 Geological Precursor Classifier \* 2166 Meteorological Precursor Classifier \*2167 Artificial Precursor Classifier Topographical Precursor Classifier \* 2168 \* 2169 Precursor Disaster Classifier \* 2170 Sferics Detector Data Classifier \* 2171 Earthquake Disaster Predictor \* 2172 Hurricane Disaster Predictor \* 2173 Tornado Disaster Predictor \* 2174 Tidal Wave Disaster Predictor \* 2175 Flood Disaster Predictor \* 2176 Volcanic Eruption Disaster Predictor \* 2177 Forest Fire Disaster Predictor \* 2178 Range Fire Disaster Predictor \* 2179 Landslide Disaster Predictor \*2180 Snowslide Disaster Predictor \*2181 Land Subsidence Disaster Predictor \* 2182 Drought Disaster Predictor Blizzard Disaster Predictor \* 2183 \*2184 TV Camera Mode Selector \*2185 Radar Receiver Operation Monitor \*2186 Sferics Detector Operation Monitor \* 2187 Recorder Control Actuator \* 2188 Geological Precursor Data Classifier \*2189 Meteorological Precursor Data Classifier \* 2190 Artificial Precursor Data Classifier \*2191 Topographical Precursor Data Classifier **\*2192** Precursor Disaster Data Classifier \*2193 Earthquake Data Classifier \*2194 Hurricane Data Classifier \*2195 Tornado Data Classifier \*2196 Tidal Wave Data Classifier \*2197 Flood Data Classifier \*2198 Volcanic Eruption Data Classifier \*2199 Forest Fire Data Classifier **\*** 2200 Range Fire Data Classifier

#2201-2250

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* 2201
          Landslide Data Classifier
 *2202
          Snowslide Data Classifier
 *2203
          Land Subsidence Data Classifier
 * 2204
          Drought Data Classifier
 *2205
          Blizzard Data Classifier
 *2206
          Geological Precursor Communicator
 * 2207
          Meteorological Precursor Communicator
 * 2208
          Artificial Precursor Communicator
 *2209
          Topographical Precursor Communicator
          Precursor Disaster Communicator
*2210
* 2211
          Earthquake Disaster Communicator
* 2212
          Hurricane Disaster Communicator
* 2213
          Tornado Disaster Communicator
* 2214
          Tidal Wave Disaster Communicator
* 2215
          Flood Disaster Communicator
* 2216
          Volcanic Eruption Disaster Communicator
* 2217
          Forest Fire Disaster Communicator
* 2218
          Range Fire Disaster Communicator
* 2219
          Landslide Disaster Communicator
* 2220
          Snowslide Disaster Communicator
* 2221
          Land Subsidence Disaster Communicator
* 2222
          Drought Disaster Communicator
* 2223
          Blizzard Disaster Communicator
* 2224
          Earthquake Disaster Identifier
* 2225
          Hurricane Disaster Identifier
* 2226
          Tornado Disaster Identifier
* 2227
          Tidal Wave Disaster Identifier
* 2228
          Flood Disaster Identifier
* 2229
          Volcanic Eruption Disaster Identifier
* 2230
          Range Fire Disaster Identifier
* 2231
          Landslide Disaster Identifier
* 2232
          Snowslide Disaster Identifier
* 2233
          Land Subsidence Disaster Identifier
* 2234
          Drought Disaster Identifier
* 2235
          Blizzard Disaster Identifier
* 2236
          Telescope Data Quality Monitor
* 2237
          Sferics Detector Repairer
* 2238
          Biological Materials Separation Planner
* 2239
          Electrophoretic Separation Research Coordinator
* 2240
          Instrumentation & Control Center Unstower
* 2241
          Ampoule Remover
* 2242
          Densitometer Inspector
* 2243
          Interferometer Inspector
* 2244
          Buffer Solution Stower
* 2245
          Biological Materials Stower
* 2246
          Instrumentation & Control Center Stower
* 2247
          Buffer Solution Flow Rate Observer
* 2248
          Electrophoretic Column Control Actuator
* 2249
          Biological Materials Data Determiner
* 2250
          Instrumentation & Control Center Fault Identifier
```

#2251-2300

Instrumentation & Control Center Repairer \* 2251 General Purpose Lab Bench Unstower \* 2252 \* 2253 Accident Control System Unstower \* 2254 Glass Processing Research Coordinator Instrumentation & Control Center Control Actuator \* 2255 \* 2256 General Purpose Lab Bench Stower \* 2257 Silicate Melt Susceptor Stower \* 2258 Accident Control System Stower \* 2259 Line Reader Installer \* 2260 General Purpose Lab Bench Control Actuator \* 2261 Accident Control System Control Actuator \* 2262 Viewing Device Control Actuator \* 2263 Glass Processing Research Monitor \* 2264 Accident Control System Operation Monitor \* 2265 General Purpose Lab Bench Fault Identifier \* 2266 General Purpose Lab Bench Repairer \* 2267 Accident Control System Fault Identifier Accident Control System Repairer \* 2268 \* 2269 Materials Analysis Equipment Inspector \* 2270 Holographic Device Inspector \* 2271 Environmental Chamber Inspector \* 2272 Power Conditioning/Distribution System Inspector \* 2273 Calorimeter Inspector \* 2274 Friction Measuring Device Inspector \* 2275 Atmosphere Analysis Unit Inspector Chill System Inspector \* 2276 \* 2277 Heat Rejection System Inspector \* 2278 Heating/Positioning Coils Inspector \* 2279 Viewing Device Inspector \* 2280 VHF Power Unit Inspector \* 2281 Accident Control System Inspector \* 2282 General Purpose Lab Bench Inspector \* 2283 Environmental Chamber Tester \* 2284 Power Conditioning/Distribution System Tester \* 2285 Calorimeter Tester \* 2286 Friction Measuring Device Tester \* 2287 Atmosphere Analysis Unit Tester \* 2288 Chill System Tester 2289 Not Assigned \* 2290 Heat Rejection System Tester \* 2291 Heating/Positioning Coil Tester \* 2292 Viewing Device Tester \* 2293 VHF Power Unit Tester \* 2294 Accident Control System Tester \* 2295 Computer Tester **\*** 2296 Viewing Device Control Deactuator **\*** 2297 Chill System Control Deactuator **\*** 2298 Crystal Growth Research Coordinator \* 2299 Crystal Growth Process Observer \* 2300

Materials Sample Structure Analyzer



.1.	0001	N . 1 0 1 0 1 1								
	2301	Metal Sample Structure Analyzer								
	2 302	Glass Sample Structure Analyzer								
	2 30 3	Crystal Growth Research Monitor								
	2304	Materials Dopant Translocator								
	2 305	Materials Dopant Unstower								
	2 306	Heating/Cooling Device Cleaner								
	2307	Heating/Cooling Device Control Deactuator								
	2 308	Sample Holder Remover								
	2 309	Composite Materials Research Coordinator								
	2310	Dispersion Control System Translocator								
	2311	Dispersion Control System Installer								
*	2 312	Dispersion Control System Remover								
*	2313	Dispersion Control System Calibrator								
*	2314	Composite Materials Sample Evaluator								
*	2 31 5	Composite Materials Research Monitor								
*	2316	Immiscible Liquid Sample Remover								
*	2317	Immiscible Liquid Sample Installer								
*	2318	Slip Casting Translocator								
*	2 31 9	Immiscible System Casting Translocator								
*	2320	Liquid Dispersions Research Coordinator								
*	2321	Mixing Equipment Controller								
*	2 322	Slip Materials Installer								
*	2323	Casting Mold Disassembler								
*	2324	Casting Mold Installer								
*	2325	Liquid Dispersion Research Status Determiner								
*	2326	Liquid Dispersion Research Monitor								
*	2327	Slip Cast Injection System Control Actuator								
*	2 328	Fluid Connection Research Coordinator								
*	2329	Fluid Connection Research Monitor								
*	2330	Test Cell Translocator								
*	2331	Test Cell Unstower								
*	2332	Peltier Heater Control Actuator								
*	2333	Crystal Growth Data Observer								
*	2334	Crystal Growth Data Interpreter								
*	2 3 3 5	Crystal Sample Installer								
*	2 3 3 6	Microscope Controller								
*	2337	Zone Melter Controller								
	- 331	Source lieter's contribution								

# WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

CONTRACT NAS8-28359

FINAL REPORT

APPENDIX F

OCCUPATIONAL SKILL DESCRIPTIONS





#### APPENDIX F

# Occupational Skill Descriptions

The methodology used in skill definition for orbital research experiments involved translation of task-skills, determined for each identified combination of task dependencies and crew functions, into standardized occupational skill categories. As explained in Section 2.0 of the report, the <u>Dictionary of Occupational Skills</u>, by the U.S. Department of Labor (References 20 and 21, Appendix A) was used as the source of standardized skill classifications, as well as the method of classification.

The following pages of this Appendix represent a composite of excerpts from the <u>Dictionary</u>, presenting in numerical order by code number, the Occupational Skill Descriptions for the Primary Occupational Skills and the Mission Occupational Skills selected during this study. At the top of each page is the six-digit classification code and the major title for the selected occupation encompassed by that title. In some cases, specialty areas within that major title are also included (under the same classification code), whether or not that specialty was encompassed by the study.

The lower portion of the page presents information of a general nature about the occupation, described partly by the last three digits of the classification code and partly by the type of work requiring that occupation. A detailed description of the method will be found in the <u>Dictionary</u>.

The "Qualifications Profile" which is part of each description includes a number of abbreviations and code designations, explained as follows:

- GED: General Educational Development. Number codes are on a scale of one (1) through six (6) and relate to increasing development levels covering reasoning ability, mathematical capability, and language development.
- SVP: Specific Vocational Preparation. This includes training given in any of the following circumstances:
  - a. Vocational education (such as high school commercial or shop training, technical school, art school, and that part of college training which is organized around a specific vocational objective);
  - b. Apprentice training (for apprenticeable jobs only);
  - c. In-plant training (given by an employer in the form of organized classroom study);
  - d. On-the-job training (serving as learner or trainee on the job under the instruction of a qualified worker);
  - e. Essential experience in other jobs (serving in less responsible jobs which lead to the higher grade job or serving in other jobs which qualify).



The following is an explanation of the various levels of specific vocational preparation.

Level Time

- 1 Short demonstration only.
- 2 Anything beyond short demonstration up and including 30 days.
- 3 Over 30 days up to and including 3 months.
- 4 Over 3 months up to and including 6 months.
- 5 Over 6 months up to and including 1 year.
- 6 Over 1 year up to and including 2 years.
- 7 Over 2 years up to and including 4 years.
- 8 Over 4 years up to and including 10 years.
- 9 Over 10 years.
- Apt.: Aptitudes. Letter codes have the following meanings.
  - G: Intelligence
  - V: Verbal
  - N: Numerical
  - S: Spatial
  - P: Form Perception
  - Q: Clerical Perception
  - K: Motor Coordination
  - F: Finger Dexterity
  - M: Manual Dexterity
  - E: Eye-Hand-Foot Coordination
  - C: Color Discrimination

The following scale is used under each aptitude letter code:

- 1 The top 10 percent of the population. This segment of the population possesses an extremely high degree of the aptitude.
- 2 The highest third exclusive of the top 10 percent of the population. This segment of the population possesses an above average or high degree of the aptitude.
- 3 The middle third of the population. This segment of the population possesses a medium degree of the aptitude, ranging from slightly below to slightly above average.
- 4 The lowest third exclusive of the bottom 10 percent of the population. This segment of the population possesses a below average or low degree of the aptitude.
- 5 The lowest 10 percent of the population. This segment of the population possesses a negligible degree of the aptitude.

Certain aptitudes appear in boldface type on the qualifications profiles for the worker-trait groups. These aptitudes are considered to be occupationally significant for the specific group; i.e., essential for average successful job performance. All boldface aptitudes are not necessarily required of a worker for each individual job within a worker trait group, but some combination of them is essential in every case.



• Int:: Interests. Preferences for certain types of work activities or experiences, with accompanying rejection of contrary types of activities or experiences. Five pairs of interest factors are provided so that a positive preference for one factor of a pair also implies rejection of the other factor of that pair.

vs.

vs.

vs.

- Situations involving a preference for activities dealing with things and objects.
- 6 Situations involving a preference for activities concerned with people and the communication of ideas.
- 2 Situations involving a preference for activities involving business contact with people.
- 7 Situations involving a preference for activities of a scientific and technical nature.
- 3 Situations involving a preference for activities of a routine, concrete, organized nature.
- 8 Situations involving a preference for activities of an abstract and creative nature.
- 4 Situations involving a vs. preference for working for people for their presumed good, as in the social welfare sense, or for dealing with people and language in social situations.
- 9 Situations involving a preference for activities that are nonsocial in nature, and are carried on in relation to processes, machines, and techniques.
- 5 Situations involving a perference for activities resulting in prestige or the esteem of others.
- O Situations involving a preference for activities resulting in tangible, productive satisfaction.
- Temp: Temperaments. Different types of occupational situations to which workers must adjust.

vs.

- 1 Situations involving a variety of duties often characterized by frequent change.
- 2 Situations involving repetitive or short cycle operations carried out according to set procedures or sequences.
- 3 Situations involving doing things only under specific instruction, allowing little or no room for independent action or judgment in working out job problems.
- 4 Situations involving the direction, control, and planning of an entire activity or the activities of others.
- 5 Situations involving the necessity of dealing with people in actual job duties beyond giving and receiving instructions.



- 6 Situations involving working alone and apart in physical isolation from others, although the activity may be integrated with that of others.
- 7 Situations involving influencing people in their opinions, attitudes, or judgments about ideas or things.
- 8 Situations involving performing adequately under stress when confronted with the critical or unexpected or when taking risks.
- 9 Situations involving the evaluation (arriving at generalizations, judgments, or decisions) of information against sensory or judgmental criteria.
- O Situations involving the evaluation (arriving at generalizations, judgments, or decisions) of information against measurable or verifiable criteria.
- X Situations involving the interpretation of feelings, ideas, or facts in terms of personal viewpoint.
- Y Situations involving the precise attainment of set limits, tolerances, or standards.
- Phys. Dem.: Physical Demands.
  - 1 Lifting, carrying, pushing, and/or pulling (strength) with the following subcodes.
    - S: Sedentary Work
    - L: Light Work
    - M: Medium Work
    - H: Heavy Work
    - V: Very Heavy Work
  - 2 Climbing and/or balancing
  - 3 Stooping, kneeling, crouching, and/or crawling
  - 4 Reaching, handling, fingering, and/or feeling
  - 5 Talking and/or hearing
  - 6 Seeing

Occupational Skill descriptions are included for the following occupational classifications:

- 003.181 Electrical Technician
- 003.187 Radio Engineer
- 003.187 Systems Engineer, EDP 003.281 Instrumentation Technician
- 007.081 Optical Technician
- 011.281 Metallurgist Assistant
- 018.188 Surveyor, Geodetic
- 022.081 Chemist, Inorganic
- 022.081 Chemist, Physical
- 023.081 Physicist, Heat
- 024.081 Geologist
- 024.081 Geophysicist
- 025.088 Meteorologist



025.288 Weather Observer

041.081 Biochemist

710.884 Calibrator

714.684 Camera Inspector

722.281 Inspector, Systems

828.281 Electronics Mechanic

Descriptions of two other skill categories (000.000, General Technical Skill; xxx.xxx, Special Spaceflight Skill) are not included herein, because they are not included in the <u>Dictionary</u>. The origin and the application of these two titles are explained in Section 3.0 of the report.



# 003.181 ELECTRICAL TECHNICIAN (profess. & kin.)

JOB DEFINITION: <u>Electric-laboratory technician</u>. Applies electrical theory and related subjects to test and modify developmental or operational electrical machinery and electrical control equipment and circuitry in industrial or commercial plants and laboratories: Assembles and tests experimental motor-control devices, switch panels, transformers, generator windings, solenoids, and other electrical equipment and components, according to engineering data and knowledge of electrical principles. Modifies electrical prototypes to correct functional deviations under direction of ELECTRICAL ENGINEER. Diagnoses cause of electrical or mechanical malfunction or failure of operational equipment and performs preventative and corrective maintenance. Develops wiring diagrams, layout drawings, and engineering specifications for system or equipment modifications or expansion, and directs personnel performing routine installation and maintenance duties. Plans, directs, and records periodic electrical testing, and recommends or initiates modification or replacement of equipment which fails to meet acceptable operating standards. modification or replacement of equipment which fails to meet acceptable operating standards.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: TECHNICAL WORK, ENGINEERING AND RELATED FIELDS (.181; .281)

WORK PERFORMED: Work activities in this group primarily involve the application of engineering-related and technical knowledge in direct support of the engineer. Typically, tasks performed are functional parts of engineering activities requiring the practical application of fundamental theory in such specialized areas as research, design, and development.

WORKER REQUIREMENTS: An occupationally significant combination of: Ability to learn and apply basic engineering and technical principles and methods; facility with mathematics and language; and spacial perception.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Success in vocational and mathematical courses in high school. Interest in current technological developments.

Subscriptions to engineering and technical magazines.

TRAINING AND METHODS OF ENTRY: Graduation from a technical institute or the completion of specialized programs in junior colleges or universities is usually required for entry into this field. A worker who has acquired the necessary knowledge of mathematics through apprenticeship or related programs also may find entry into this field.

#### RELATED CLASSIFICATIONS

Technical Work, Science and Related Fields (.384) Materials Analysis and Related Work (.181; .281; .381) Drafting and Related Work (.181; .281) Engineering and Related Work (.187)

# QUALIFICATIONS PROFILE\*

SVP: 6 GVN Apt:

2 2 2 3 3 3 2 2 2 2 2 3 3 3 3 3

Int: 9 Temp:

Phys. Dem: SLM

 <sup>\*</sup>For explanation, see page F-1



# 003.187 RADIO ENGINEER (radio & TV broad.)

JOB DEFINITION: Engineer, chief; engineer-in-charge; radio operator, chief; station engineer; technician, senior. Operates and maintains station audio and video transmission equipment in compliance with federal regulations: Diagnoses cause for malfunctions and oversees workers in adjusting and repairing station technical equipment. Tunes transmitter for most efficient operation. Oversees TRANSMITTER OPERATORS and instructs them in new operating methods.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: ENGINEERING AND RELATED WORK (.187)

WORK PERFORMED: Work activities in this group primarily involve the application of engineering knowledge to the planning, direction, and installation of projects and systems. Typically, workers are concerned with a specific field of engineering, such as civil engineering, mechanical engineering, and electrical engineering.

WORKER REQUIREMENTS: An occupationally significant combination of: Organizational ability; clear verbal expression; ability to learn and apply engineering principles and methods; spatial and form perception; and facility with mathematics.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:
Expressed interest in industrial developments.
Success in pertinent academic subjects, such as mathematics.
Subscriptions to engineering and technical magazines.

TRAINING AND METHODS OF ENTRY: A bachelor's degree in engineering is usually the minimum educational requirement for entrance into this field, and many employers are now requiring a graduate degree in engineering.

#### RELATED CLASSIFICATIONS:

Industrial Engineering and Related Work (.188; .288)
Engineering Research and Design (.081)
Technical Work, Engineering and Related Fields
(.181; .281)
Engineering, Scientific, and Technical Coordination
(.168)
Technical Writing and Related Work (.188; .288)
Drafting and Related Work (.181; .281)

## QUALIFICATIONS PROFILE\*

GED: 6 SVP: 8 G V. N SPQ Apt: 2 2 4 4 4 4 2 2 2 Int: 1 7 9 4 0 Temp: Phys. Dem: S L 6

<sup>\*</sup>For explanation, see page F-1



#### 003.187 SYSTEMS ENGINEER, ELECTRONIC DATA PROCESSING (profess. & kin.)

JOB DEFINITION: <u>Computer systems engineer</u>; <u>methods analyst</u>, <u>electronic data processing</u>. Analyzes electronic data processing projects to determine equipment requirements: Confers with MANAGER, ELECTRONIC DATA PROCESSING, concerning availability and capabilities of equipment in current use, and with PROJECT DIRECTOR, BUSINESS DATA PROCESSING, to specify computer system requirements for projects. Analyzes capabilities and limitations of computers and peripheral equipment, such as data recording, communication, input, output, and synchronizing (buffering) devices, in order to recommend most feasible new equipment or equipment modifications. Plans layout of computers and peripheral equipment to achieve efficient operation and effective use of assigned space. May specify power supply requirements and configuration and recommend purchase and arrangement of air conditioning equipment to control temperature, humidity, and dust. May specialize in one area of equipment application or in one make or type of equipment. Usually is employed as representative of consulting firm or equipment manufacturer.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: ENGINEERING AND RELATED WORK (.187)

WORK PERFORMED: Work activities in this group primarily involve the application of engineering knowledge to the planning, direction, and installation of projects and systems. Typically, workers are concerned with a specific field of engineering, such as civil engineering, mechanical engineering, and electrical engineering.

WORKER REQUIREMENTS: An occupationally significant combination of: Organizational ability; clear verbal expression; ability to learn and apply engineering principles and methods; spatial and form perception; and facility with mathematics.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:
Expressed interest in industrial developments.
Success in pertinent academic subjects, such as mathematics.
Subscriptions to engineering and technical magazines.

TRAINING AND METHODS OF ENTRY: A bachelor's degree in engineering is usually the minimum educational requirement for entrance into this field, and many employers are now requiring a graduate degree in engineering.

#### RELATED CLASSIFICATIONS:

# Industrial Engineering and Related Work (.188; .288) Engineering Research and Design (.081) Technical Work, Engineering and Related Fields (.181; .281) Engineering, Scientific, and Technical Coordination (.168) Technical Writing and Related Work (.188; .288) Drafting and Related Work (.181; .281)

#### QUALIFICATIONS PROFILE\*

GED: 6 5 8 7 G V N SVP: Apt: SPQ E C 111 2 2 4 4 4 4 5 5 2 2 2 3 3 Int: 1 7 9 4 0 Temp: Phys. Dem:

<sup>\*</sup>For explanation, see page F-1



#### 003.281 INSTRUMENTATION TECHNICIAN (profess. & kin.)

JOB DEFINITION: Devises, sets up, and operates electronic instrumentation and related electromechanical or electrohydraulic apparatus involved in operational and environmental testing of mechanical, structural, or electrical equipment, and translates test data for subsequent use by engineering personnel in making engineering design and evaluation decisions: Selects, installs, calibrates, and checks out sensing, telemetering, and recording instrumentation and circuitry, and develops specifications for nonstandard apparatus according to engineering data, characteristics of equipment under test, and capabilities of procurable test apparatus. Sketches and builds or modifies jigs, fixtures, instruments, and related apparatus, and verifies dimensional and functional acceptability of devices fabricated by craft or technical personnel. Performs preventive and corrective maintenance of test apparatus and peripheral equipment. Directs technical personnel in installation of object in test chamber of other test facility. Operates test apparatus during test cycle to produce, regulate, and record effects of actual or simulated conditions, such as vibration, stress, temperature, humidity, pressure, altitude, and acceleration. Mathematically reduces test data to usable form, and prepares graphs and written reports to translate test results into meaningful terms such as speed-temperature-horsepower ratios. May plan complete test program. May be designated according to equipment tested as ROCKET-CONTROL TECHNICIAN, or according to nature of test as ENVIRONMENTAL-RESEARCH-TEST TECHNICIAN.

#### AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: TECHNICAL WORK, ENGINEERING AND RELATED FIELDS (.181; .281)

WORK PERFORMED: Work activities in this group primarily involve the application of engineering related and technical knowledge in direct support of the engineer. Typically, tasks performed are functional parts of engineering activities requiring the practical application of fundamental theory in such specialized areas as research, design, and development.

WORKER REQUIREMENTS: An occupationally significant combination of: Ability to learn and apply basic engineering and technical principles and methods; facility with mathematics and language; and spatial perception.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Success in vocational and mathematical courses in high school. Interest in current technological developments.

Subscriptions to engineering and technical magazines.

TRAINING AND METHODS OF ENTRY: Graduation from a technical institute or the completion of specialized programs in junior colleges or universities is usually required for entry into this field. A worker who has acquired the necessary knowledge of mathematics through apprenticeship or related programs also may find entry into this field.

# RELATED CLASSIFICATIONS:

Technical Work, Science and Related Fields (.384) Materials Analysis and Related Work (.181; .281; .381)
Drafting and Related Work (.181; .281) Engineering and Related Work (.187)

# QUALIFICATIONS PROFILE\*

GED: SVP: 6

GVN Apt: E C 3 3 2 2 2 3 3

3 3

3

2 2 2 3 3 3 7 9 Int: Υ 0 Temp:

Phys. Dem: SLM

<sup>\*</sup>For explanation, see page F-1



#### 007.081 OPTICAL TECHNICIAN (optical goods) I

JOB DEFINITION: Designs mechanical portion of precision optical instruments, such as aerial cameras, spectrophotometers, and refractometers: Reviews optical specifications to determine types of mounts, test lenses, tools, and fixtures required, and sequence of operations necessary for construction of optical system. Draws sketches of mechanical parts, such as retaining rings, diaphragms, and barrel mounts, following blueprints and work orders. Devises equipment for testing optical system. Tests system to determine working characteristics and conformance to specifications, using standard and modified optical test equipment and procedures. May assemble optical and mechanical elements to construct instruments, using handtools.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: ENGINEERING RESEARCH AND DESIGN (.081)

WORK PERFORMED: Work activities in this group primarily involve using and adapting earth substances, properties of matter, natural sources of power, and physical forces to satisfy human needs and desires. Typically, workers are engaged in conducting analyses and experiments of materials and systems by applirypicarry, workers are engaged in conducting analyses and designing new structures, machines, tools, precision instruments, and other devices; in devising and constructing cooling, heating, lighting, communication, transportation, and other productive systems; in developing the most practical forms of new techniques, processes, and products; in performing structural, functional, and compositional tests of materials and parts; and in preparing technical reports of investigations.

WORKER REQUIREMENTS: An occupationally significant combination of: Ability to learn and apply basic engineering principles and methods; good visual acuity with respect to graphic representations; creative talent or imagination; ability to perceive or visualize spatial relationships of plane and solid objects; logical mind; organizational ability; and facility in mathematics.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Level of attainment in language and mathematics as indicated by scores on aptitude tests and grades in educational courses.

Previous drawings or sketches produced, either freehand or mechanical Kind of literature read (whether scienfically or technically oriented).

Clear, coherent verbal expression.

Interest in scientific and technological developments.

TRAINING AND METHODS OF ENTRY: A bachelor's degree in engineering is usually the minimum educational requirement for entrance into this field. However, some draftsmen and engineering technicians having extensive experience together with some college-level training may qualify for entry.

Most employers require either advanced graduate degrees or significant experience on the basic engineering

level for entry into research work.

Students interested in engineering should acquire a strong background in mathematics and the physical sciences.

#### RELATED CLASSIFICATIONS

Sales Engineering (.151) Engineering, Scientific, and Technical Coordination (.168) Engineering and Related Work (.187) Technical Work, Engineering and Related Fields (.181; .281)
Industrial Engineering and Related Work (.188; .288) Drafting and Related Work (.181; .281)

#### QUALIFICATIONS PROFILE\*

GED: SVP: 8 7 Apt: GVN SPQ K F ME C 111 1 2 4 3 3 3 5 4 2 2 2 3 7 Int: 8 4 0 Temp: Phys. Dem: S L

<sup>\*</sup>For explanation, see page F-1



#### 011.281 METALLURGIST, ASSISTANT (profess. & kin.)

JOB DEFINITION: Metallurgical-laboratory assistant; metallurgical tester; physical-laboratory assistant. Examines and tests metal samples to determine their physical properties, under direction of METALLURGIST, PHYSICAL. Conducts routine microscopic examinations of metals and alloys to determine their crystalline structure, porosity, homogeneity, and other characteristics. Prepares photographs of metal specimens, using photomicroscope, studies and interprets photographs, and compiles reports of findings. Examines metal and alloy samples with X-ray, gamma-ray, and magnetic-flux equipment to detect internal fractures, impurities, and similar defects in metals. Tests samples in pressure devices, hot-acid baths, and other apparatus to determine strength, hardness, elasticity, toughness, or other properties of metal.

AREA OF WORK: INVESTIGATING, INSPECTING AND TESTING

WORKER TRAITS GROUP: MATERIALS ANALYSIS AND RELATED WORK (.181; .281; .381).

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and related diciplines to the analysis, testing, and compounding of such materials as ores, foods, chemicals, and drugs. Activities range from primarily subjective evaluations, such as food-tasting, to objective evaluations of test data on the properties of such materials as fuels, gems, and textiles.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual ability and interest sufficient to acquire necessary academic background; attention to detail; a facility with mathematics; and form perception to recognize physical differences in materials.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Expressed preference for research work.

Academic success in science and laboratory courses in college or other scholastic environment.

Active participation in extracurricular science activities. Experience assisting instructors in course work in sciences.

TRAINING AND METHODS OF ENTRY: Employers prefer to hire workers who have completed some courses in mathematics, engineering, chemistry, or physics, including related laboratory work. These workers are then given the opportunity to become proficient through on-the-job training. Some of these activities require the worker to have a bachelor's degree and be licensed by the State.

#### RELATED CLASSIFICATIONS

Appraising and Investigating Work (.187; .284; .287)
Inspecting and Stock Checking (.382; .384; .387; .484; .487)
Sorting, Inspecting, Measuring, and Related Work (.484; .485; .487; .584; .585; .683; .684; .685; .687)
Mathematics, Physical Sciences, and Related Research (.088; .188)
Scientific Research (.081)

#### QUALIFICATIONS PROFILE\*

GED: 5 4 SVP: 7 6 5 Apt: G V N S P Q K F M E C 2 2 3 3 2 4 3 3 3 5 3 1 3 2 4 3 3 4 4 4 4 1 1 1 2 3

Int: 1 7 9 Temp: 0 Y Phys. Dem: L 4

<sup>\*</sup>For explanation, see page F-1



018.188 SURVEYOR, GEODETIC (profess. & kin.).

JOB DEFINITION: Plans, directs, or conducts surveys of land areas of such size that shape and size of earth exerts sufficient influence on survey measurements to require use of special high-accuracy techniques including astronomical observations and complex computations to compile data used in preparation of geodetic maps and charts.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: SURVEYING, PROSPECTING, AND RELATED WORK (.188; .288)

WORK PERFORMED: Work activities in this group primarily involve determining and delineating the shape, size, location, and other aspects of natural and manmade objects or features on the earth's surface, and in exploring and examining underground earth formations. Typically, workers are engaged in taking linear and angular measurements of tracts of land; in obtaining and interpreting seismograms and other graphic indications or records of the composition and structure of underground formations; in locating positions of aircraft and directing their courses; in obtaining knowledge of particular terrains and presence or absence of mammade objects or features by studying aerial photographs; and in preparing maps, charts, sketches, and other graphic representations from the data collected.

WORKER REQUIREMENTS: An occupationally significant combination of: An understanding of the principles of geometry and trigonometry; a strong liking for outdoor work; ability to draw; finger dexterity; good vision and health; physical stamina, and the ability to perceive relationships of objects in space or to envision objects of two or three dimensions on flat surfaces.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Level of attainment in language and mathematics as indicated by scores on aptitude tests and grades in educational courses.

Drawings or sketches produced, either freehand or mechanical. Participation in outdoor activities, such as scouting, hiking, or camping.

Hobbies, such as rock collecting.

Night school pre-engineering courses.

TRAINING AND METHODS OF ENTRY: A high school education is usually the minimum requirement for entry into the kinds of work described in this group. Adequate academic preparation should include courses in map reading, freehand and mechanical drawing, mathematics, geography, and the earth sciences.

Summer employment with surveying or prospecting teams in the construction or petroleum industries provides an excellent opportunity for students and others to obtain experience. Some employers offer formal courses in surveying with accompanying on-the-job training in survey techniques and in the use of surveying instruments.

Some technical or vocational schools, as well as some colleges, offer comprehensive programs in surveying. Extension courses are also available.

RELATED CLASSIFICATIONS:

Mathematics, Physical Sciences, and Related Research (.088, .188) Engineering and Related Work (.187) Drafting and Related Work (.181; .281) Materials Analysis and Related Work (.181; .281; .381) OUALIFICATIONS PROFILE\*

GED: .5 6

SVP:

GVN Apt: 2 2 2 2 2 3 3 `3 3

3

7 Int: 1

0 Υ Temp:

Phys. Dem: M 2

<sup>\*</sup>For explanation, see page F-1



#### 022.081 CHEMIST, INORGANIC (profess. & kin.)

JOB DEFINITION: Conducts experiments on substances which are free or relatively free of carbon to develop and improve materials and products and to discover scientific facts: Prepares new inorganic compounds and and improve materials and products and to discover scientific facts: Prepares new inorganic compounds and investigates possibilities of application to medicine, industry, and other fields and areas. Develops new methods for preparing existing inorganic compounds. Records results of experiments and writes reports recommending application of further research. Engages in research to improve chemical methods for processing inorganic materials. May analyze metals, ores, gases, heavy chemicals, and other inorganic compounds to determine factors, such as composition, structure, chemical properties, and value, and to develop methods to improve these qualities. May specialize in particular element or class of compounds or specific industry or product.

SPECIALTY AREAS: CHEMIST, GLASS (glass mfg.) Glass Technologist. Conducts experiments in chemistry of glass, and develops and controls processes involved in manufacture of glass products: Devises and installs laboratory and batch-control systems. Selects formulas to be used in compounding standard types of glass, and develops new formulas to produce special-purpose glass, such as optical glass, glass ovenware, or colored glass products. Directs activities of operating crew engaged in compounding ingredients and charging melting furnaces. Ascertains furnace temperatures periodically with optical pyrometer, and makes necessary temperature adjustments. Determines characteristics of glass samples by subjecting them to chemical and physical tests.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Expressed preference for research work. Academic success in scientific coursework in college. Active participation in extracurricular science activities. Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field, with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.

### RELATED CLASSIFICATIONS:

Materials Analysis and Related Work (.181; .281; . 381 \ High School, College, University, Tutoring, and Related Education (.228) Health Physics (.021) Mathematics, Physical Sciences, and Related Research (.088; .188) Technical Work, Science and Related Fields (.384) Engineering, Scientific, and Technical Coordination (.168)

## **OUALIFICATIONS PROFILE\***

GED: 5 6 SVP: 8 GVN Apt: SPO KFM 2 2 2 2 2 2 2 3 3 3 4 3 Int: 1 7. 8 1 9 0 Temp: ٧ Phys. Dem: S

L 2

<sup>\*</sup>For explanation, see page F-I



#### 022.081 CHEMIST, PHYSICAL (profess. & kin.)

JOB DEFINITION: Conducts research into relationships between chemical and physical properties of organic and inorganic substances and compounds: Determines atomic and molecular weights of substances, including crystal forms, using X-ray diffraction, thermomagnetic analysis, microporosity measurement, and other techniques. Measures heat of substances under varying conditions to determine boiling and freezing points and to ascertain physical and chemical characteristics under those conditions. Induces changes in composition of substances by introduction of thermal, light, and electrical energy and chemical catalysts. Studies rate of chemical reaction and determines catalytic action required to increase reaction rate. Examines molecules to ascertain structure, electrical energy, and reaction to energy changes, using electron microscope and other instruments. Develops techniques for use of instruments that measure heat, light, and electricity.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Expressed preference for research work.
Academic success in scientific coursework in college.
Active participation in extracurricular science activities.
Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field, with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.

#### RELATED CLASSIFICATIONS:

Materials Analysis and Related Work (.181; .281; .381)
High School, College, University, Tutoring, and Related Education (.228)
Health Physics (.021)
Mathematics, Physical Sciences, and Related Research (.088; .188)
Technical Work, Science and Related Fields (.384)
Engineering, Scientific, and Technical Coordination (.168)

# QUALIFICATIONS PROFILE\*

GED: SVP: Apt:	5 6 7 8 G V N 1 1 1 2 2 2	S P Q 1 1 1 2 2 2	K F M 2 2 2 3 3 3	E C 3 2 4 3	
Int:	1 7	8		5	
	1 9 Dem:		3 1 5	6	

<sup>\*</sup>For explanation, see page F-1



#### 023.081 PHYSICIST (profess. & kin.)

JOB DEFINITION: Conducts research into phases of physical phenomena, develops theories and laws on basis of observation and experiments, and devises methods to apply laws and theories of physics to industry, medicine, and other fields: Performs experiments with masers, lasers, cyclotrons, betatrons, telescopes, mass spectrometers, electron microscopes, and other equipment to observe structure and properties of matter, transformation and propagation of energy, relationships between matter and energy, and other physical phenomena. Describes and expresses observations and conclusions in mathematical terms. Devises procedures for physical testing of materials. Conducts instrumental analyses to determine physical properties of materials. May apply methodology of physics to a particular physical property or phenomenon. May engage in teaching.

SPECIALTY AREAS: PHYSICIST, HEAT (profess. & kin.) Physicist, Thermodynamics. Conducts research into nature and properties of heat and its conversion into energy: Performs experiments involving measurement, development, transmission, and effects of heat. Studies effects of low and high temperatures on physical properties of matter. Devises methods to solve such problems as reducing heat loss in fuel consumption and in operation of jet engines. Develops techniques and instruments for observation of materials at high or low temperatures. Examines relationship between amount of heat expended and energy involved.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Expressed preference for research work.

Academic success in scientific coursework in college.

Active participation in extracurricular science activities.

Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field, with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.

#### RELATED CLASSIFICATIONS:

(.168)

Materials Analysis and Related Work (.181; .281; .381)
High School, College, University, Tutoring, and Related Education (.228)
Health Physics (.021)
Mathematics, Physical Sciences, and Related Research (.088; .188)
Technical Work, Science and Related Fields (.384)
Engineering, Scientific, and Technical Coordination

# QUALIFICATIONS PROFILE\*

GED: SVP: 7 8 G V N SPQ Apt: KFM E C 111 1 1 1 2 2 2 3 2 3 3 2 2 2 2 2 4 3 înt: 1 1 9 0 Temp: Phys. Dem: S L 2 3

<sup>\*</sup>For explanation, see page F-1



### 024.081 GEOLOGIST (profess. & kin.)

JOB DEFINITION: Studies composition, structure, and history of earth's crust: Examines rocks, minerals, and fossil remains to identify and determine sequence of processes affecting development of earth. Applies knowledge of chemistry, physics, biology, and mathematics to explain these phenomena and to help locate mineral and petroleum deposits and underground water resources. Studies ocean bottom. Applies geological knowledge to engineering problems encountered in construction projects, such as dams, tunnels, and large buildings. Studies fossil plants and animals to determine their evolutionary sequence and age. Prepares geologic reports and maps, interprets research data, and recommends further study or action. May specialize in area of study and be designated GEOLOGIST, ENGINEERING; GEOLOGIST, GROUND WATER; GEOLOGIST, MINING.

SPECIALTY AREAS: GEOLOGIST, PETROLEUM (petrol. production). Explores and charts stratigraphic arrangement and composition of earth to locate gas and oil deposits: Studies well logs, analyzes cores and cuttings from well drillings, and interprets data obtained by electrical or radioactive well logging and other subsurface surveys to identify earth strata. Examines aerial photographs, evaluates results of geophysical prospecting, and prepares surface and subsurface maps and diagrams depicting stratigraphic arrangement and composition of earth and probable deposits of gas and oil. Recommends acquisition, retention, or release of property leases or contracts. Estimates oil reserves in proven or prospective fields, and consults with PETROLEUM ENGINEERS concerning drilling and production methods. May direct drilling of shallow exploratory wells. GEOMORPHOLOGIST (profess. & kin.). Studies form of earth's surface and forces, such as erosion, glaciation, and sedimentation, causing changes in land formation.
MINEPALOGIST (profess. & kin.). Examines, analyzes and classifies minerals, gems, and precious stones:
Isolates specimen from ore, rocks, or matrices. Makes microscopic examination to determine shape, surface markings, and other physical characteristics. Performs physical and chemical tests and makes X-ray examinations to determine composition of specimen and type of crystalline structure. Identifies and classifies samples. Develops data and theories on mode of origin, occurrence, and possible uses of minerals. OCEANOGRAPHER, GEOLOGICAL (profess. & kin.). Geologist, Narine. Studies topographic features, rocks and sediments of ocean bottom.
PALEONTOLOGIST (profess. & kin.). Studies fossilized remains of plants and animals found in geological formations to trace evolution and development of past life and identify geological formations according to nature and chronology. Recovers and assembles fossilized specimens, notes their positions, and classifies them according to their botanical or zoological family and probable

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:
Expressed preference for research work.
Academic success in scientific coursework in college.
Active participation in extracurricular science activities.
Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field, with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.



024.081 GEOLOGIST (profess. & kin.). (Continued)
AREA OF WORK: MATHEMATICS AND SCIENCE (Continued)

#### RELATED CLASSIFICATIONS

Materials Analysis and Related Work (.181; .281; .381)
High School, College, University, Tutoring, and
Related Education (.228)
Health Physics (.021)
Mathematics, Physical Sciences, and Related Research
(.088; .188)
Technical Work, Science and Related Fields (.384)
Engineering, Scientific, and Technical Coordination
(.168)

#### QUALIFICATIONS PROFILE\*

<sup>\*</sup>For explanation, see page F-1



#### 024.081 GEOPHYSICIST (profess. & kin.)

JOB DEFINITION: Studies physical aspects of earth, including its atmosphere and hydrosphere: Investigates and measures seismic, gravitational, electrical, thermal, and magnetic forces affecting earth, utilizing principles of physics, mathematics, and chemistry. Analyzes data obtained to compute shape of earth, estimate composition and structure of earth's interior, determine flow pattern of ocean tides and currents, study physical properties of atmosphere, and help to locate petroleum and mineral deposits. Investigates origin and activity of glaciers, volcanoes, and earthquakes. Compiles data to prepare navigational charts and maps, predict atmospheric conditions, and establish water supply and flood-control programs.

SPECIALTY AREAS: 'GEODESIST (profess. & kin.). Employs surveying and geodetic instruments, such as transits, theodolites, and other engineering instruments, in setting up and improving network of triangulation over earth's surface in order to provide fixed points for use in making maps. Establishes bench marks (known points of elevation). Performs gravimetric surveying to determine variations in earth's gravitational field, and provides data used in determination of weight, size, and mass of earth. GEOMAGNETICIAN (profess. & kin.). Terrestrial Magnetician. Sets up magnetic observatories and stations to chart earth's magnetic field. Applies data obtained to problems in fields of telephony, telegraphy, radio broadcasting, navigation, mapping, and geophysical prospecting.

GEOPHYSICAL PROSPECTOR (petrol. production). Studies structure of subsurface rock formations to locate petroleum deposits, using such physical and electrical testing instruments as seismograph, gravimeter, torsion balance, magnetometer, pendulum devices, and electrical-resistivity apparatus to measure various characteristics of earth. Computes, from instrument readings, variations in physical forces existing at different locations, and interprets data to reveal subsurface structures likely to contain petroleum deposits. Prepares charts, profiles, or subsurface contour maps. Determines desirable locations for drilling operation. Oversees field crews drilling shallow boreholes in designated terrain and collecting samples of soil for chemical PROSPECTOR; GRAVITY PROSPECTOR; MAGNETIC PROSPECTOR; SEISMIC PROSPECTOR. GLACIOLOGIST (profess. & kin.). Studies effects of glaciation in changing surface of earth.

HYDROLOGIST (profess. & kin.). Studies distribution, disposition, and development of waters of land areas, including form and intensity of precipitation, and modes of return to ocean and atmosphere. Maps and charts water flow and disposition of sediment. Measures changes in water volume due to evaporation and melting of snow. Studies storm occurrences and nature and movement of glaciers, and determines rate of ground absorption and ultimate disposition of water. Evaluates data obtained in reference to such problems as flood and drought forecasting, soil and water conservation programs, and planning water supply, water power, flood control, drainage, irrigation, crop production, and inland navigation projects.

OCEANOGRAPHER, PHYSICAL (profess. & kin). Studies physical aspects of ocean, such as density, temperature, and ability to transmit light and sound; movement of sea, such as waves, tides, and currents; and relationship between sea and atmosphere. SEISMOLOGIST (profess. & kin.). Works at fixed locations throughout globe and studies courses and phenomena of earthquakes, using special devices and machines, including seismograph. Establishes existence of active fault lines or areas where earthquakes have occurred and near which it would be hazardous to build cities, dams, or lofty structures. TECTONOPHYSICIST (profess. & kin.). Studies elastic deformation of flow and rupture of constituent materials

Camb, or lotty structures.

TECTONOPHYSICIST (profess. & kin.). Studies elastic deformation of flow and rupture of constituent materials of earth's crust and makes deductions concerning forces causing these deformations (changes). Studies formation of strata underlying continents and ocean beds, and forces at work in earth's crust, and general structure of coastal layers. Work is mostly research and findings applicable to prospecting.

VOLCANOLOGIST (profess. & kin.). Studies occurrence, origin, and activity of volcanoes; origin of igneous rocks; and ore-forming processes occurring in earth in presence of igneous rock. Performs duties as described under GEOPHYSICAL PROSPECTOR (petrol. production) in studying ore bodies that may be commercially exploitable.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORK REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:
Expressed preference for research work.
Academic success in scientific coursework in college.
Active participation in extracurricular science activities.
Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.



024.081 GEOPHYSICIST (profess. & kin.) (Continued)

AREA OF WORK: MATHEMATICS AND SCIENCE (Continued)

RELATED CLASSIFICATIONS:

QUALIFICATIONS PROFILE\*

Materials Analysis and Related Work (.181; .281; .381)
High School, College, University, Tutoring, and Related Education (.228)
Health Physics (.021)
Mathematics, Physical Sciences, and Related Research (.088; .188)
Technical Work, Science and Related Fields (.384)
Engineering, Scientific, and Technical Coordination (.168)

GED: 5 6 SVP: 7 8 Apt: G V N S P Q 1 1 1 K F M 2 2 2 3 3 3 2 2 2 2 2 2

Int: 1 7 8 Temp: 1 9 0 Y Phys. Dem: S L 2 3 4 5 6

<sup>\*</sup>For explanation, see page F-1



#### 025.088 METEOROLOGIST (profess. & kin.).

JOB DEFINITION: Synoptic meteorologist; weather forecaster; weather man. Studies and interprets atmospheric conditions and related meteorological data to forecast immediate and long range changes in weather: Analyzes and interprets synoptic charts, maps, prognostic charts, and meteorological data, such as barometric pressure, temperature, humidity, wind velocity, and areas of precipitation, to make forecast. Investigates meteorological aspects of radio propagation, aurora and air glow, and cosmic rays. Conducts research into long range forecasting [CLIMATOLOGIST], severe weather phenomena, solar heating, and other problems. Draws isobars on surface maps, indicating fronts, areas of precipitation, high and low barometric pressure, and falling and rising pressure, and predicts movements of fronts, precipitation, and pressure areas. Advises AIRPLANE PILOT, COMMERCIAL (air trans.) and other flight personnel regarding meteorological data, such as winds aloft, ceilings, visibility, icing conditions, thunderstorms, and other forms of turbulence, and movements of cloud formations.

SPECIALTY AREAS: CLIMATOLOGIST (profess. & kin.). Interprets statistical data on wind, rainfall, sunshine, temperature, and other aspects of climate of particular area over extended period of time to predict future climatic conditions. Develops and utilizes statistical and other methods to analyze and interpret climatological data.

#### AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: MATHEMATICS, PHYSICAL SCIENCES, AND RELATED RESEARCH (.088; .188)

WORK PERFORMED: Work activities in this group primarily involve investigation into atmospheric, astronomical, and geographical phenomena and conditions, into theoretical aspects of physics and mathematics, and into automatic data-processing systems and programs. Typically, workers are engaged in collecting and analyzing data on the nature, composition, structure, and other features of the earth, atmosphere, and celestial bodies; in formulating theories on time, space, weather, matter and energy, motion of heavenly bodies, and other aspects of the physical world; in analyzing data-processing problems, stating problems in computer language, and determining computational methods and sequence of machine operations for solution of problems; in developing new mathematical and statistical methods, formulas, and relationships; and in communicating research findings through reports, lectures, technical publications, and other media.

WORKER REQUIREMENTS: An occupationally significant combination of: Ability to understand the basic laws of nature and scientific methods of investigation; inventiveness; ability to represent and relate abstract ideas by means of symbols; organizational ability; retentive memory; clerical perception; lucid verbal expression; ability to perceive or envision relative paths or positions of stationary and moving objects; and the ability to grasp mathematical and statistical concepts.

CLUES FOR RELATING APPLICANT AND REQUIREMENTS:

Level of attainment in language and mathematics as indicated by scores on aptitude tests and grades in school.

Interest in figures or numbers.

Interest in scientific and technological developments.

Kind of literature read (whether scientifically oriented or not).

TRAINING AND METHODS OF ENTRY: A bachelor's degree in the appropriate subject matter, such as mathematics, astronomy, and geography, is a minimum educational requirement for entrance into this type of work. For the more responsible research positions an advanced degree is necessary. A Ph.D. is usually essential for entrance into astronomy. Workers in pure mathematics seldom require training in a particular field, but those in applied mathematics must acquire knowledge of the field in which mathematics is used.

#### **RELATED CLASSIFICATIONS:**

Scientific Research (.081)
High School, College, University, Tutoring, and
Related Education (.228)
Engineering, Scientific, and Technical Coordination
(.168)
Materials Analysis and Related Work (.181; .281; .381)
Technical Work, Science and Related Fields (.384)

#### QUALIFICATIONS PROFILE\*

GED: 7 SVP: 8 Apt: GVN SPQ KFM E C 1 3 2 2 3 4 4 4 1 1 1 2 2 2 Int: 7 8 4 Temp: 0 Phys. Dem: S 4 6

<sup>\*</sup>For explanation, see page F-1



#### 025.288 WEATHER OBSERVER (profess. & kin.).

JOB DEFINITION: Meteorological aid. Observes and records weather conditions for use in forecasting: Periodically observes general weather, sky and visibility conditions, and reads weather instruments including thermometers, barometers, and hydrometers to ascertain elements, such as temperature, barometric pressure, wind velocity, visibility, and precipitation. Calculates winds aloft by following ballon's ascent with theodolite, recording angles of azimuth and elevation at specific time intervals, and converting readings into wind speed and direction, using charts and mathematical tables. Decodes weather data received by teletypewriter and plots synoptic charts of large geographical areas, such as North America.

SPECIALTY AREAS: WEATHER-CHART PREPARER (profess. & kin.) <u>Meteorological plotter</u>; <u>weather-chart plotter</u>. Plots weather maps and charts from weather reports on basis of which weather forecasts are made: <u>Employs</u> code books and knowledge of code to decode weather observations received by teletypewriter from observation stations covering large geographical areas such as North America. Records weather data on synoptic maps using standard meteorological symbols to construct large numbers of station models showing elements, such as barometric pressure, temperature, cloud cover, precipitation, and visibility. Decodes data and plots upperair charts, winds-aloft maps, and radiosonde soundings.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: SURVEYING, PROSPECTING, AND RELATED WORK (.188; .288)

WORK PERFORMED: Work activities in this group primarily involve determining and delineating the shape, size, location, and other aspects of natural and manmade objects or features on the earth's surface, and in exploring and examining underground earth formations. Typically, workers are engaged in taking linear and angular measurements of tracts of land; in obtaining and interpreting seismograms and other graphic indications or records of the composition and structure of underground formations; in locating positions of aircraft and directing their courses; in obtaining knowledge of particular terrains and presence or absence of manmade objects or features by studying aerial photographs; and in preparing maps, charts, sketches, and other graphic representations from the data collected.

WORKER REQUIREMENTS: An occupationally significant combination of: An understanding of the principles of geometry and trigonometry; strong liking for outdoor work; ability to draw; finger dexterity; good vision and health; physical stamina, and the ability to perceive relationships of objects in space or to envision objects of two or three dimensions on flat surfaces.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Level in attainment in language and mathematics as indicated by scores on aptitude tests and grades in educational courses.

Drawings or sketches produced, either freehand or mechanical.

Participation in outdoor activities, such as scouting, hiking, or camping.

Hobbies, such as rock collecting.

Night school pre-engineering courses.

TRAINING AND METHODS OF ENTRY: A high school education is usually the minimum requirement for entry into the

kinds of work described in this group. Adequate academic preparation should include courses in map reading, freehand and mechanical drawing, mathematics, geography, and the earth sciences.

Summer employment with surveying or prospecting teams in the construction or petroleum industries provides an excellent opportunity for students and others to obtain experience. Some employers offer formal courses in

Some technical or vocational schools, as well as some colleges, offer comprehensive programs in surveying. Extension courses are also available.

# RELATED CLASSIFICATIONS:

Mathematics, Physical Sciences, and Related Research (.088; .188) Engineering and Related Work (.187)

Drafting and Related Work (.181; .281) Materials Analysis and Related Work (.181; .281; .381) QUALIFICATIONS PROFILE\*

GED: 5 7 SVP: 6

GVN Apt: SP Q 3 2 2 2 2 2

3 7 Int: 9 1 0 Υ TempL

Phys. Dem: M 2 L

<sup>\*</sup>For explanation, see page F-1



### 041.081 BIOCHEMIST

JOB DEFINITION: Chemist, biological. Studies chemical processes of living organisms: Conducts research to determine action of foods, drugs, serums, hormones, and other substances on tissues and vital processes of living organisms. Isolates, analyzes, and identifies hormones, vitamins, allergens, minerals, and enzymes and determines effects on body functions. Examines chemical aspects of formation of antibodies, and conducts research into chemistry of cells and blood corpuscles. Studies chemistry of body processes such as breathing and digestion, and of living energy changes such as growth, aging, and death. May specialize in particular area or field of work, and be designated CHEMIST, CLINICAL; CHEMIST, ENZYMES; CHEMIST, PROTEINS; CHEMIST, STEROIDS. May clean, purify, refine, and otherwise prepare pharmaceutical compounds for commercial distribution, develop new drugs and medications, and be designated CHEMIST, PHARMACEUTICAL.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Expressed preference for research work.
Academic success in scientific coursework in college.
Active participation in extracurricular science activities.
Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field, with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.

### RELATED CLASSIFICATIONS:

### Materials Analysis and Related Work (.181; .281; .381) High School, College, University, Tutoring, and Related Education (.228) Health Physics (.021) Mathematics, Physical Sciences, and Related Research (.088; .188) Technical Work, Science and Related Fields (.384) Engineering, Scientific, and Technical Coordination (.168)

### QUALIFICATIONS PROFILE\*

GED:	56			
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	222	222	3 3 3	4 3
		3		5

Int: 1 7 8 Temp: 1 9 0 Y

Phys. Dem: S L 2 3 4 5 6

<sup>\*</sup>For explanation, see page F-1



### 710.884 CALIBRATOR (inst. & app.)

JOB DEFINITION: I. Performs any combination of tasks involved in calibrating control instruments, such as thermostats, timing, and pressure-regulating devices: Selects and installs adapter and indicating gages on test fixture according to written specifications. Sets controls to regulate current flow, timing cycle, pressure, or temperature to specifications for device being tested. Positions dial plate of controls at reference point and adjusts calibration screw so that contact points open and close at specified temperature or pressure. Bends contact blades of device to adjust blades for length of travel time, using feeler gages and hand tools. Positions potentiometer blades to obtain specified galvanometer reading, using screwdriver and feeler gage. Places sealing compound on adjustment screws to prevent readjustment of breaker points. II. Tests calibration of barometer assemblies, using vacuum chamber: Positions assemblies on racks in vacuum chamber. Connects each assembly to lead of radio transmitter. Records serial number of each barometer assembly on paper tape where signal will appear. Starts vacuum pump to decrease atmospheric pressure in chamber. Stops pump and turns valve to admit air to chamber and increase pressure. Barometer assembly activates transmitter that gives off signals indicating functional characteristics of assembly. Signals are recorded on paper tape. Removes paper tape and reads recorded signals. Removes defective assemblies from chamber and routes them for repairs or adjustments.

AREA OF WORK: CRAFTS

WORKER TRAITS GROUP: MANIPULATING (.884)

WORK PERFORMED: Work activities in this group primarily involve the dexterous use of hands, hand tools, or special devices to work, move, guide, or place objects or materials. There exists some latitude for judgment in selecting the appropriate tools, objects, or materials, and in determining work procedures and conformance to standards, although all these factors are fairly obvious. The work most frequently occurs away from a machine-oriented environment, and is prevalent in such endeavors as bench crafts, structural work, and hunting and fishing.

WORKER REQUIREMENTS: An occupationally significant combination of: Eye-hand coordination; manual and finger dexterity; spatial and form perception; a decided preference for working with the hands; the ability to work within prescribed standards and specifications; and facility in adapting to a routine.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:
Success in craft courses in school.
Hobby of making scale-model boats and airplanes.
Expressed preference for working with the hands.
Hobbies of hunting and fishing.

TRAINING AND METHODS OF ENTRY: Apprenticeship programs and on-the-job training are the usual means by which a worker becomes familiar with his job. On occasions, experience in a lesser capacity can prepare an applicant for entry into this type of work, provided he has shown diligence and the capacity for more involved tasks. Individuals with some exposure to disciplined and standardized work methods in a school or related environment will usually be given preference.

RELATED CLASSIFICATIONS

Craftsmanship and Related Work (.281; .381) Tending (.885) Feeding-Offbearing (.886) Handling (.887) QUALIFICATIONS PROFILE\* GED: 2 3 4 SVP: 5 GVN SPQ Apt: KFM E C 34 4 3 5 3 3 5 5 5 3 4 4 4 4 4 4 3 Int: 9 3 l 2 γ

Temp: 2 Y Phys. Dem: S L M H 2 3 4 6

<sup>\*</sup>For explanation, see page F-1



### 714.684 CAMERA INSPECTOR (photo. apparatus)

JOB DEFINITION: Photographic-equipment inspector. Inspects still or motion picture cameras, magazines, enlargers, flash units, film developing machines, and other photographic equipment: Examines equipment for defects, such as missing parts, incorrect serial numbers, flaws in castings, and light leakage, and verifies timing and focus. Trips shutter to verify timing, using timing device. Measures focal distance of lenses, using depth micrometer. Tests electrical components, using electrical instruments. May be designated according to item inspected, as CAMERA-CASING INSPECTOR; FILM-ROLLER INSPECTOR; MOTION-PICTURE-CAMERA INSPECTOR.

### AREA OF WORK: INVESTIGATING, INSPECTING, AND TESTING

WORKER TRAITS GROUP: SORTING, INSPECTING, MEASURING, AND RELATED WORK (.484; .485; .487; .584; .585; .587; .683; .684; .685; .687).

WORK PERFORMED: Work activities in this group primarily involve examining, measuring, or weighing objects or materials for the purpose of grading, sorting, detecting flaws or irregularities, or verifying adherence to specifications. The work frequently is performed under close supervision, and the use of gages, calipers, micrometers, and other measuring devices or equipment, as well as the primary senses, is often involved.

WORKER REQUIREMENTS: An occupationally significant combination of: The ability and willingness to follow instructions to the letter; spatial and form perception to perceive differences in tangible matter; accuracy and attention to detail; finger and manual dexterity; eye-hand coordination; and disposition toward work of a routine, repetitive, and noncreative nature.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

School shop courses indicating success in working to tolerances.

Willingness to fit into a routine.

Casual work experience sorting stock at inventory time in local plant.

TRAINING AND METHODS OF ENTRY: Workers generally learn the fundamentals of their jobs during a brief period of on-the-job training, which may range from a few hours to several months, depending on the skill required. Many employers prefer workers with no previous experience. They look for applicants who are physically able, dependable, have good eyesight, and can follow instructions. Many of the larger employers give aptitude tests in selecting new employees.

### RELATED CLASSIFICATIONS

Inspecting and Stock Checking (.382; .384; .387; .484; .487)
Routine Checking and Recording (.588; .688)
Tending (.884)

### QUALIFICATIONS PROFILE\*

SVP: 2 3 4 ĞΫ́Ν SPQ KFM E C Apt: 4 4 4 4 4 4 4 4 3 4 3 5 3 3 3 3 3 4 5 3 Int: 1 3 9

Temp: 2 Y 0 3

Phys. Dem: S L M 4 5 6

<sup>\*</sup>For explanation, see page F-1



### 722.281 INSPECTOR, SYSTEMS (Electronics)

JOB DEFINITION: <u>Inspector</u>, <u>electronic assembly</u>; <u>quality-control inspector</u>, <u>electronic assembly</u>. Inspects electronic systems, such as radar navigation, telemetering equipment, and computer memory units, following blueprints, wiring diagrams, customer or contract specifications, and manufacturing standards, and using precision measuring instruments: Compares layout and installation of wiring, cables, subassemblies, hardware, and components with specifications to detect assembly errors. Examines joints, using magnifying glass and mirrors, and pulls wires and cables to locate soldering defects. Twists parts, such as dials, shafts, and gears, to verify operation of parts. Measures parts for conformance with specified dimensions, using precision measuring instruments, such as micrometers and vernier gages. Records inspection data, such as serial numbers of inspected equipment, type and amount of defects, and rework required for defective equipment. Stamps inspected equipment to indicate acceptance. May resolder broken connections. May perform functional tests, using electronic test equipment, such as frequency meters, oscilloscopes, and power measuring instruments [TESTER, SYSTEMS].

AREA OF WORK: CRAFTS

WORKER TRAITS GROUP: CRAFTSMANSHIP AND RELATED WORK (.281; .381).

WORK PERFORMED: Work activities in this group primarily involve fabricating, processing, inspecting, or repairing material, products, or structural units. Activities in this group are characterized by the emphasis placed upon manual skills, and the application of an organized body of knowledge related to materials, tools, and principles associated with various crafts.

WORK REQUIREMENTS: An occupationally significant combination of: Ability to learn and apply craft techniques, processes, and principles; ability to use independent judgment in planning sequence of operations and in selecting proper tools and materials; ability to assume responsibility for attainment of prescribed qualitative standards; ability to apply shop mathematics to practical problems, such as computing dimensions and locating reference points from specifications data when laying out work; spatial perception to visualize arrangement and relationships of static or moving parts and assemblies represented in blueprints and diagrams; form perception as required in such activities as inspecting finished work to verify acceptability of surface finish; and some combination of finger and manual dexterity and eye-hand coordination to use handtools and manually controlled power tools when executing work to close tolerances.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Hobbies, such as model building or ceramics, which involve hand craftsmanship. Successful completion of high school industrial arts or vocational education courses. Military training and experience in craft-related activities.

Preference for work activities offering tangible productive satisfaction.

TRAINING AND METHODS OF ENTRY: Apprenticeships providing 2 to 6 years of on-the-job training and trade instruction are generally accepted as the best methods of entry into craft work. Many firms have established on-the-job training programs in which entry workers are placed under the supervision of a journeyman or a foreman and are advanced from elementary tasks to progressively more difficult work as they demonstrate increased proficiency in the skills of the craft. Training received in vocational, trade, or technical schools or the armed services enhance entry and advancement prospects, and may shorten training periods in some crafts. Craftsmen who become thoroughly familiar with all aspects of their trade through apprenticeship training generally stand the best chance for advancement to supervisory positions.

### RELATED CLASSIFICATIONS

Drafting and Related Work (.181; .281) Manipulating (.884) Cooking and Related Work (.281; .381) Precision Working (.781)

### QUALIFICATIONS PROFILE\*

GFD: 4 7 6 G V N SVP: 8 SPQ Apt: KFME C 3 3 3 2 2 2 3 3 3 2 3 4 5 ž 3 4 2 4 4 4 2 3 3 Int: 1 9 0

Temp: 0 Y Phys. Dem: L M H 2 3 4 6

<sup>\*</sup>For explanation, see page F-1



### 828.281 ELECTRONICS MECHANIC (any ind.)

JOB DEFINITION: Communication technician; electronics-equipment mechanic; electronics-maintenance man; electronics specialist; electronics-system mechanic; electronics technician. Repairs electronic equipment, such as computers, industrial controls, radar systems, telemetering and missile control systems, transmitters, antennas, and servomechanisms, following blueprints and manufacturers' specifications, and using handtools and test instruments: Tests faulty equipment and applies knowledge of functional operation of electronic units and systems to diagnose cause of malfunction. Tests electronic components and circuits to locate defects, using instruments, such as oscilloscopes, signal generators, ammeters, and voltmeters. Replaces defective components and wiring and adjusts mechanical parts, using handtools and soldering iron. Aligns, adjusts, and calibrates equipment according to specifications. Calibrates testing instruments. Maintains records of repairs, calibrations, and tests. May install equipment in industrial or military establishments and in aircraft and missiles. May operate equipment, such as communication equipment and missile control systems in ground and flight tests, and may be required to hold license from governmental agency. May be designated according to type of equipment repaired as ELECTRONICS MECHANIC, COMPUTER; RADAR MECHANIC.

SPECIALTY AREAS: COMPONENT-INSPECTION TECHNICIAN (electronics). Inspects and repairs electronic computer components and subassemblies, following schematic diagrams and specifications and using handtools and electronic testing instruments. Records inspection results and replacements made. CUSTOMER-ENGINEERING SPECIALIST (office mach.) field-service technician, computers. Installs and repairs electronic computers and auxiliary equipment in company plant and at customers' establishments in accordance with written diagnostic and maintenance procedures and diagrams, using handtools and electronic testing instruments, such as oscilloscope and multimeters. Keeps performance records of computers serviced. Advises customers concerning operation, maintenance, and programming of computers.

### AREA OF WORK: CRAFTS

WORKER TRAITS GROUP: CRAFTSMANSHIP AND RELATED WORK (.281; .381).

WORK PERFORMED: Work activities in this group primarily involve fabricating, processing, inspecting, or repairing materials, products, or structural units. Activities in this group are characterized by the emphasis placed upon manual skills, and the application of an organized body of knowledge related to materials, tools, and principles associated with various crafts.

WORK REQUIREMENTS: An occupationally significant combination of: Ability to learn and apply craft techniques, processes, and principles; ability to use independent judgment in planning sequence of operations and in selecting proper tools and materials; ability to assume responsibility for attainment of prescribed qualitative standards; ability to apply shop mathematics to practical problems, such as computing dimensions and locating reference points from specifications data when laying out work; spatial perception to visualize arrangement and relationships of static or moving parts and assemblies represented in blueprints and diagrams; form perception as required in such activities as inspecting finished work to verify acceptability of surface finish; and some combination of finger and manual dexterity and eye-hand coordination to use handtools and manually controlled power tools when executing work to close tolerances.

### CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Hobbies, such as model building or ceramics, which involve hand craftsmanship.
Successful completion of high school industrial arts or vocational education courses.
Military training and experience in craft-related activities.
Preference for work activities offering tangible productive satisfaction.

TRAINING METHODS OF ENTRY: Apprenticeships providing 2 to 6 years of on-the-job training and trade instruction are generally accepted as the best methods of entry into craft work. Many firms have established on-the-job training programs in which entry workers are placed under the supervision of a journeyman or a foreman and are advanced from elementary tasks to progressively more difficult work as they demonstrate increased proficiency in the skills of the craft. Training received in vocational, trade, or technical schools or the armed services enhance entry and advancement prospects, and may shorten training periods in some crafts. Craftsmen who become thoroughly familiar with all aspects of their trade through apprenticeship training generally stand the best chance for advancement to supervisory positions.

### RELATED CLASSIFICATIONS

Drafting and Related Work (.181; .281) Manipulating (.884) Cooking and Related Work (.281; .381) Precision Working (.781)

### QUALIFICATIONS PROFILE\*

Phys. Dem:

GED: SVP: 6 8 GVN Apt: SPQ KFM 3 3 3 2 3 4 3 3 3 5 5 2 4 4 3 4 2 2 2 3 Int: 1 9 Temp: n Υ

L M H 2

<sup>\*</sup>For explanation, see page F-1

### DEVELOPMENT OF FLIGHT EXPERIMENT WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

**CONTRACT NAS8-28359** 

FINAL REPORT

APPENDIX G
WORKSTATION CONCEPTS SUPPORTING DATA





### APPENDIX G

### WORKSTATION CONCEPTS SUPPORTING DATA

The data presented in this appendix was generated during the analysis which lead to the development of the integrated Sortie Lab Control/Display console concepts reported in Section 4.0 of the report. It is included here to provide explanatory information for those users of the document who are dealing primarily with equipment allocation and design problems. Portions of this data, e.g., the subsystem cost summary data, were developed jointly under this contract and other URS/Matrix study efforts, both contracted and in-house.



### SORTIE LAB - MISSION/EQUIPMENT CROSS REFERENCE EARTH OBSERVATIONS PAYLOADS

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NOTES: • = Equipment Utilization Planned.

<sup>? =</sup> Equipment Utilization Possible but not Verified.

<sup>\* =</sup> Task Dependency not Identified.

x = Payload/Mission Correlation.



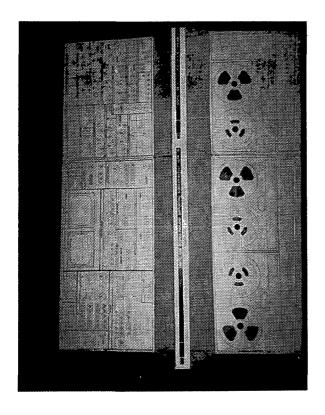
### SORTIE LAB - MISSION/EQUIPMENT CROSS REFERENCE MATERIALS SCIENCES PAYLOADS/EXPERIMENTS

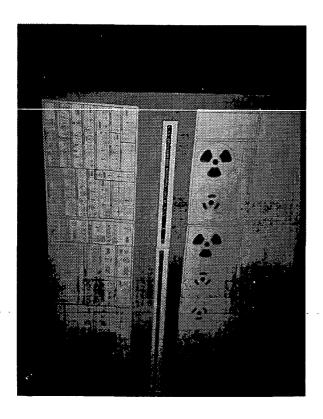
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B-03						Cooling	<del></del>	╀	⊢		<u> </u>	<del>  -</del>			-			1
B-95 Biological Enclosure B-98 B-97 B-98 B-99 Instrumentation and Control Center B-98 B-99 B-99 B-99 B-99 B-99 B-99 B-99	1							1	-									1
B-97   General Purpose Laborator v Instillation						, cooming		•	•	۳	╀╾	┞	-	-	<del>-</del>	<u> </u>		
B-08	<u> </u>		<u> </u>		ory Instal	lation			Ť	0	╁~	╁╌	┢	•	•	0	4 D 22-1	2 B 06-5
B-09   Afmosphere Supply and Control System								-			9	9	•		_	<u> </u>		
B-10   Power Conditioning/Distribution System		Atmos	sphere Su	ipply and	Control Sy	ystem		0	+						•	•		2.B.06-7
1-04   Heating/Positioning Coils (Set)	B-10	Power	r Conditio	oning/Dist	ribution S	ystem		0	•					•	0	•	4.D.13	2.B.06-9
1-07   Dispersion Control System	1-01					С.				•		•	•	•	•		2.D.24-1	2.B.06-10
1-98								L	L	•	•	•	_					
1-11   Zone Melter				<del></del>				L	<u> </u>	<b>└</b>	L	<u> </u>	•	0	•		·	
1-12   Crockralski Crystal Puller				Deployme	nt System			ļ	_	<u> </u>	<u> </u>	<u> </u>	<u> </u>	?	ļ			<del></del>
1-13								<u> </u>	⊢	⊢	<del> </del>				<u> </u>			
1-18								├	├	-	├-	•	├—	⊢	⊢	•		
Fig.   Seed Injector			*					<del> </del>	-	-		$\vdash$	├	<del>                                     </del>		$\vdash$		
1-16				die Calori	meter			┢	$\vdash$	┢	┞		┝	-	-	Н		
1-18				on Measur	na Device	e		┢	╁		•		_	┢	-			<del></del>
1-19							v	•	<u> </u>	-	Ť	$\vdash$	┢	-	-	-		<del></del>
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1-21					<del></del>	·		•			T				$\vdash$		2.D.40	2.B.06-21
E-02									•									<del></del>
E-03	E-01									•	•	0					2.D.34	2.B.06-27
E-05 Television Camera E-05 Remote Measuring Device (Mass; Dimensions) E-06 Remote Measuring Device (Mass; Dimensions) E-07 Mixing Unit-Liquid/Liquid; Liquid/Solid E-08 Mixing Unit-Liquid/Cas E-09 Mixing Unit-Liquid/Cas E-09 Slip Cast Injection System E-10 Vibrator E-11 Microscope Stage Attachment E-13 UV Densitometer (Microdensitometer) E-14 Holographic Interferometer E-15 Model Zone Refiner E-17 Variable High Frequency Power Unit E-19 Process Control Computer S-00 Heat Rejection System T-10 Vibrator F-17 Variable High Frequency Power Unit S-01 Process Control Computer T-10 Vibrator T-10 Vibrator T-10 Vibrator T-11 Vibrator T-12 Vibrator T-13 UV Densitometer (Microdensitometer) T-14 Holographic Interferometer T-15 Model Zone Refiner T-17 Variable High Frequency Power Unit T-17 Variable High Frequency Power Unit T-18 Variable High Frequency Power Unit T-19 Trocess Control Computer T-10 Vibrator T-10				ure Viewi	ng Device			_	<u>_</u>	•		0	L	<u>_</u>	<u> </u>			
E-05		Chill	System	· · · · · · · · · · · · · · · · · · ·				_		<u> </u>	0		_		<u> </u>			
E-06   Remote Measuring Device (Mass; Dimensions)					6mm.)			<u> </u>	L	_	Ļ	Щ	_					<u> </u>
E-07 Mixing Unit-Liquid/Cas E-08 Mixing Unit-Liquid/Gas Sijp Cast Injection System Sijp Cast Injection System Size The System Sijp Cast Injection System Size The System Sijp Cast Injection System Size Attachment Size Attachment System Size Attachment System Size Attachment System Size Attachment System Size Attachment System Size Attachment System Size Attachment System Size Attachment System System Size Attachment System Sy					Marri	Dimonsion		•	L				ļ		•			
E-08	<del></del>						5)		┝	•	9	•				_		
E-09 Slip Cast Injection System  E-10 Vibrator  Wibrator					ia, Liquic	1/30Hu		-	-	$\vdash$	$\vdash$	Н	۳		-	-		<del></del>
E-10 Vibrator  E-11 Microscope Stage Attachment  E-13 UV Densitometer (Microdensitometer)  E-14 Holographic Interferometer  E-15 Model Zone Refiner  Wariable High Frequency Power Unit  S-01 Process Control Computer  S-02 Heat Rejection System  Total Materials Analysis Equipment  S-05 Photographic Processing Lab.  S-07 Controlled Atmosphere Fluids Storage  Accident Control System  MS-1 Biological  Experiments (2) Preservation of Biologicals  Experiments (2) Supercooling  Experiments (2) Supercooling  MS-3 Furnace  (1) Composite Materials  MS-3 Furnace  (1) Composite Materials  MS-3 Furnace  (1) Composite Materials  Experiments (2) Directional Solidification  MS-4 Small & Low (1) Physics of Fluids  Temp. Expt's (2) Zone Refining  MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MIS2B FLIGHT FLIGHT  NO MISIE MISIF MISIC MISSB FLIGHT FLIGHT  NO MISIE MISIF MISIC MISSB FLIGHT FLIGHT  NO MISIE MISIF MISIC MISSB FLIGHT FLIGHT  NO MISIE MISIF MISIC MISSB FLIGHT FLIGHT  NO MISIE MISIF MISIC MISSB FLIGHT FLIGHT  NO MISIE MISIF MISIC MISIE MISIT MISIC MISSB FLIGHT FLIGHT  NO MISIE MISIT MISIC MISIE MISIT MISIC MISIE MISIT MISIC MISIE MISIT MISIC MISIE MISIT					n			H	$\vdash$	<u> </u>	-	Н	Н	-				
E-11	E-10							$\vdash$	$\vdash$	$\vdash$	$\vdash$	Н	•		6	$\vdash$		
E-14	E-11	Micro	scope Sta	ge Attachr	nent						┢	0	Ť	Ť		0	2.D.56	2.B.06-18
E-15 Model Zone Refiner  E-17 Variable High Frequency Power Unit  S-01 Process Control Computer  S-02 Heat Rejection System  S-04 Materials Analysis Equipment  S-05 Photographic Processing Lab.  S-07 Controlled Atmosphere Fluids Storage  S-08 Accident Control System  MS-1 Biological  (1) Separation of Biologicals  Experiments (2) Preservation of Biologicals  S-2 Levitation  MS-2 Levitation  (1) Classes  MS-3 Furnace  MS-3 Furnace  MS-3 Furnace  (1) Composite Materials  MS-4 Small & Low  (1) Physics of Fluids  Experiments (2) Directional Solidification  MS-4 Small & Low  MS-1 Biological  MS-2 Levitation  MS-3 Furnace  (1) Composite Materials  Experiments (2) Directional Solidification  MS-4 Small & Low  MS-1 Small & Low  MS-2 Levitation  MS-2 Levitation  MS-4 Small & Low  MS-1 Small & Low  MS-1 Small & Low  MS-2 Small & Low  MS-3 Small & Low  MS-4 Small & Low  MS-3 Small & Low  MS-4 Small & Low  MS-4 Small & Low  MS-8 Small & Low  MS-9 Small & Low  MS-1 Small & Low  MS-1 Small & Low  MS-1 Small & Low  MS-2 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-4 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-3 Small & Low  MS-4	E-13					er)		•									2.A.40-2	2.B.06-8
E-17 Variable High Frequency Power Unit  S-01 Process Control Computer  S-02 Heat Rejection System  S-04 Materials Analysis Equipment  S-05 Photographic Processing Lab.  S-07 Controlled Atmosphere Fluids Storage  Accident Control System  MS-1 Biological (1) Separation of Biologicals  Experiments (2) Preservation of Biologicals  Experiments (2) Preservation of Biologicals  Experiments (2) Supercooling  MS-2 Levitation (1) Classes  Experiments (2) Supercooling  MS-3 Furnace (3) "Some" Crystals  MS-4 Small 6 Low (1) Physics of Fluids  Temp. Exp'ts (2) Zone Refining  MISIE MISIF MISIG MIS2B FLIGHT FLIGHT NO.  MISIE MISIF MISIG MIS2B FLIGHT FLIGHT NO.  MISIE MISIF MISIG MIS2B FLIGHT FLIGHT NO.  A 1980 -1					er			•							•			
S-01								<u> </u>			L.			L		$\overline{}$		
S-02   Heat Rejection System						nit		_	_				•		_	-		
S-04 Materials Analysis Equipment S-05 Photographic Processing Lab. S-07 Controlled Atmosphere Fluids Storage S-08 Accident Control System  MS-1 Biological (1) Separation of Biologicals Experiments (2) Preservation of Biologicals  MS-2 Levitation (1) Classes Experiments (2) Supercooling (3) "Some" Crystals  MS-3 Furnace (1) Composite Materials Experiments (2) Directional Solidification MS-4 Small & Low (1) Physics of Fluids Temp. Exp'ts (2) Zone Refining  MISIE MISIF MISIG MISZB FLICHT FLICHT NO.  WAY NO BY NO					<u>r</u>				$\vdash$		_		-		Ι,	_		
S-05					ment			_	-	-	Ľ	H	<u>.</u>	-	-	_		1.6.02-14
S-07   Controlled Atmosphere Fluids Storage	<b></b>									-		Н	Н	,	,	_		
S-08   Accident Control System						age		•	•	:		1						· · · · · · · · · · · · · · · · · · ·
MS-1 Biological   (1)   Separation of Biologicals   x   x   x   x   x   x   x   x   x									Ť	0	•	0	0	•	ĺ	0		
Experiments (2) Preservation of Biologicals   X									-			П						
Experiments (2) Preservation of Biologicals   X								Н		_	<u> </u>	$\dashv$	Н	_		-		
MS-4 Small & Low   (1) Physics of Fluids	-							×	┝┈┤		$\vdash$	${oldsymbol{arphi}}$			Н	_		
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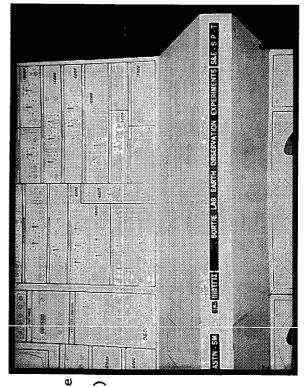
NOTES: ● = Equipment Utilization Planned.

x= Payload/Mission Correlation.

<sup>? =</sup> Equipment Utilization Possible but not Verified.

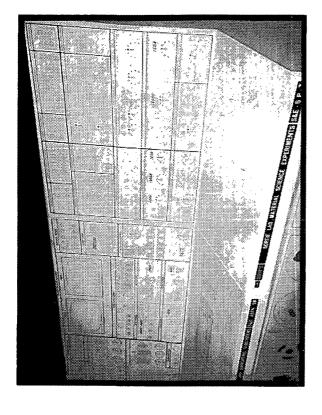


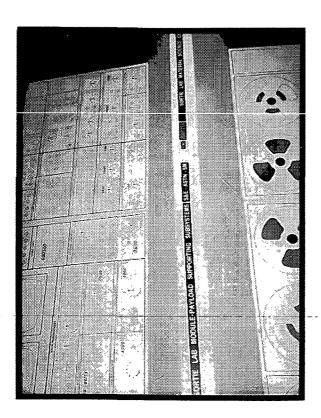


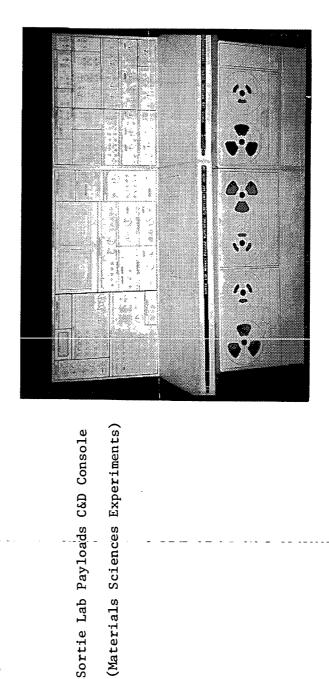


Sortie Lab Payloads C&D Console (Earth Observations Experiments)

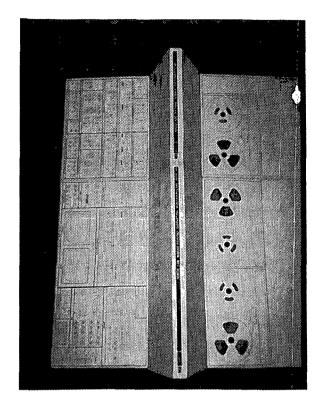


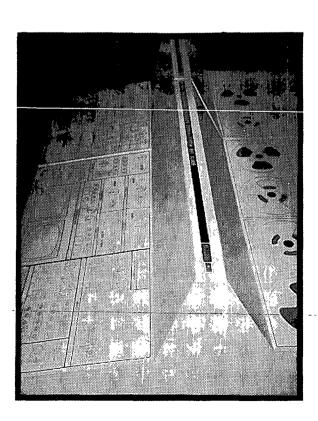


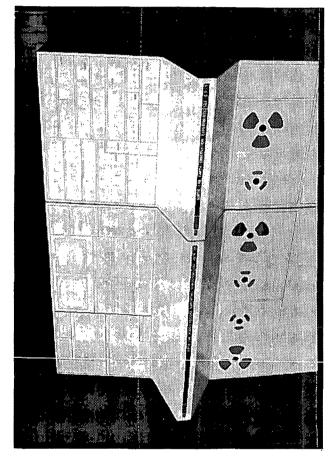




Sortie Lab Payloads C&D Console







Sortie Lab Payloads C&D Console
(Materials Sciences Experiments
and
Earth Observations Experiments)

## SORTIE LAB SUPPORTING SUBSYSTEMS

# CONTROL/DISPLAY REQUIREMENTS ANALYSIS

- DATA MANAGEMENT
- ATTITUDE/STABILITY CONTROL

ENVIRON. CONTROL/LIFE SUPPORT

- COMMUNICATIONS
- CAUTION AND WARNING

LIGHTING

POWER

# REF: • SORTIE LAB PROGRAM TASK TEAM REPORTS

- RAM STUDY (PHASE B) TECHNICAL DATA (GDC)
- SOAR I AND II STUDIES TECHNICAL DATA (MDAC)
- SKYLAB PROGRAM TECHNICAL DATA (NASA/MSFC)

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SORTI	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	ITS AN	\LYSI		SUBSYSTEM/EXP: DATA MANAGEMENT	AGEMENT
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
	• Computer/Data Processor			• Multipurpose display function keyboard.	ø Multipurpose video.	• A/N keyboard/CRT (data mgt./ storage.
	<ul> <li>Multipurpose Scientific/Checkout System</li> </ul>			• Programmable input.	o Data display video.	• Keyboard/CRT
	• External Visual Surveillance of Payload, (4 areas)			On-off/area select, field of view, angle of view, magnifica- tion, and focus.	• Video monitor (2).	• CRT
	• Voice Recording			• Start-stop, record, erase, playback and volume.	• Level and recording time remaining.	• Experiment communications.
	• Data Recording, Analog			• Start-stop, record, playback, and speed.	• Tape remaining/ status.	• Experiment/mission data.
	• Data Recording, Digital			• Start-stop, record, playback, and speed.	<pre>• Tape remaining/ status.</pre>	• Experiment/mission data.
	• Event Timing			• Min/sec slew, start- stop.	<pre>\$ Clock (hr/min/sec), tone alarm.</pre>	<ul> <li>Experiment function timing</li> </ul>
	• Video Recording			• Start-stop, record, playback, and speed.	• Tape remaining/ status.	
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SORTII	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	NTS AN,	ALYSI		SUBSYSTEM/EXP: COMMU	COMMUNICATIONS
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
	• Voice - Interstation (Cabin) - Orbiter - Ground Station			<pre>0 On-off/mode,     Station select,     Channel select.</pre>	·	• VHF and K-band/S-band (via Orbiter).
	<ul><li>Command/Experiment Data</li><li>Video Data</li></ul>			(Part of Data Management System)	nt.	<ul><li>To/from Orbiter</li><li>S-band (via Orbiter)</li></ul>
	• Computer Data • Text/Graphics			(Part of Data Management System)	int	<ul><li>See Data Management</li><li>TBD</li></ul>
	• Facsimile					• TBD

SORTII	EMEN.	TS ANALYSIS	YSIS	SUB	SUBSYSTEM/EXP: POWER SYSTEM	SYSTEM
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO. E	EXP.	CONTROLS	DISPLAYS	REMARKS
	• Fuel Cell O <sub>2</sub> Input Temperature		0	Activate displays for monitoring fuel cell O <sub>2</sub> input temp.	<ul> <li>0 o input temperature monitor.</li> <li>Automatic indicator for out-of-tolerance temp.</li> </ul>	• Display should indicate tempera- ture in degrees farenheit.
	• Fuel Cell H <sub>2</sub> Input Temperature		0	Activate display for monitoring fuel cell H <sub>2</sub> input temp.	• H, input temperature monitor. • Automatic indicator for out-of-tolerance temp.	• Display should indicate tempera- ture in degrees farenheit.
	• Fuel Cell H <sub>2</sub> 0 Output Temperature		o	Activate display for monitoring fuel cell H <sub>2</sub> O output temp.	• H <sub>2</sub> O output tempera- ture monitor. • Automatic indicator for out-of-tolerance temp.	o Display should indicate tempera- ture in degrees farenheit.
	• Fuel Cell Internal Temperature		0	Activate display for monitoring fuel cell internal temperature.	• Internal temperature monitor. • Automatic indicator for out-of-tolerance temp.	Display should indicate temperature in degrees farenheit.
	• Fuel Cell O <sub>2</sub> Input Pressure	· · · · · · · · · · · · · · · · · · ·	•	Activate display for monitoring $0_2$ input pressure.	• 0, input pressure monitor. • Automatic indicator for out-of-tolerance pressure.	<ul> <li>Display should indicate input pressure in PSI.</li> </ul>
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SORTIE LAB CONTROL/DISPLAY REQUIREMENTS
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SORT	SORTIE LAB CONTROL/DISPLAY REQUIREMENT	VTS ANALYSIS	LYSI		SUBSYSTEM/EXP: POWE	POWER SYSTEM (CONTINUED)
EQUIP. NO.	. SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
	• Fuel Cell O <sub>2</sub> Inlet Valve			ø Open/close valve	<ul><li>Indicate valve status</li></ul>	§ Indicate valve status of Control should be discrete, display should show open, closed, and in-transition.
	e Fuel Cell H <sub>2</sub> Inlet Valve		***************************************	• Open/close valve	• Indicate valve status •	o Control should be discrete, display should show open, closed,
	• Fuel Cell Purge	•		• Open and close cell $0_2$ and $H_2$ purge valves	• Indicate status of valves.	One control may open and close both valves; display should indicate for each valve whether it is open, closed, or in transition
r to de la tempe	• Fuel Cell Output Voltage (28vdc)			N/A ` .	• Display output volt- age (vdc)	
	• Fuel Cell Output Power (28vdc)	·		N/A	• Display output power (watts)	
	• Fuel Cell Output Voltage (115 vac)			N/A	<ul> <li>Display output voltage (vac)</li> </ul>	
:	• Fuel Cell Output Power (115 vac)	"	···	. W/A	• Display output power (watts)	
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SORTI	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	TS AN	\LYS!!		SUBSYSTEM/EXP: LIGH1	XP: LIGHTING SYSTEM
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
	• Cabin Lighting			a Adjust cabin lighting	N/A	<pre>% Allows variable lighting control capability.</pre>
	- Floodilgnts • External Lighting		57	a Activate/deactivate	N/A	o Allows observation of externally mounted hardware
<b>Igage -2</b> .	- Floodlights			• External floodlights		
	• Panel Lighting			• Adjust panel lighting	N/A	<ul> <li>Allows variable control of console back-lighted EL.</li> </ul>
No. of the management	• Display Lighting			<ul> <li>Adjust display light- ing.</li> </ul>	N/A	• Allows variable control of back- lighted displays.
	• Lighting Test			Select and actuate	• Display test feedback.•	
	- Attitude - Caution & Warning Displays					with an unregulated fixed power supply.
	- Numeric					
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SORTI	2	NTS AN	S ANALYSIS		SUBSYSTEM/EXP: ATTITUDE	ATTITUDE/STABILITY CONTROL
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	· DISPLAYS	REMARKS
The state of the second st	<ul> <li>Vehicle Orientation Monitoring</li> <li>Pitch</li> <li>Yaw</li> <li>Roll</li> <li>Orbital Plane Error</li> </ul>			• Mode Select - Orbiter - Sortie Lab - Payload	• Pitch, yaw, roll, and Orbital Plane in sec.	• Pitch, yaw, roll, and • Monitor Orbiter/Sortie Lab and Orbital Plane in sec. payload attitude/stability
and the second second second second second second second second second second second second second second seco	• Payload Platform Stability			• Pitch, yaw, roll control input (attitudes and rates)	o Same as above	• Same as above
	• Star Tracker Pointing - Pitch - Yaw			• Mode Select · - Manual (pitch & .yaw) - Automatic	Pitch and yaw coordinates	• Experiment reference
	• Sun Sensor				·	• See Earth Obs. Data
	• CMG System (3 Systems)				• Temp., current, speed.• System status	• System status
	• Momentum Management					o If required
		·				

SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	TS AN	LYSIS		SUBSYSTEM/EXP: ENVIRONME	EXP: ENVIRONMENTAL CONTROL/LIFE SUPPORT
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
	• Orbiter/Sortie Lab Press. Equilization			• Open-close		<ul><li>Balance pressures</li></ul>
	• Circulation Fan(s)			o On−off		
<del></del>	• Temperature Maintenance - 'Coolant Flow			• On-off/flow rate		• Heat exchanger
<del></del>	- Heater				e Temp. °F	
	<ul> <li>Humidity Maintenance</li> </ul>			• On-off/regulate	• Rel. humidity	<ul> <li>Automatic after setting</li> </ul>
	• 0 <sub>2</sub> /N <sub>2</sub> part. Press.			<pre>0 On-off/regulate</pre>	$\circ$ 0 <sub>2</sub> /N <sub>2</sub> PP monitor	<ul> <li>Automatic after setting</li> </ul>
<u> </u>	• Cabin Pressure Relief			• On-off/variable		a To overboard vent
	• Cabin Temp. Bypass			• Open close		<ul> <li>To by pass air conditioning sys.</li> </ul>
	Payload Coolant Control			• Pump, on-off (2) • By pass, on-off (2) • Power • Flow rate	• Coolant temp., in/ out payload temp.	<ul> <li>Maintain temp. stability of payload on pallet.</li> </ul>
	Radiator Deployment			• Deploy/retract		• Erect booms, etc.
<del></del>						

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SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	TS ANA	LYSIS		UBSYSTEM/EXP: CAUTION	SUBSYSTEM/EXP: CAUTION AND WARNING
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS *	DISPLAYS **	REMARKS
	  Temperature  - Badiator	·			Caution	Out-of-Tol.
Sin No. 7 Si	- Air Cooling System - Experiment(s)					
	Pressure (Atmosphere)				Caution/Warning	Out-of-Tol.
22.1516	Contamination (Atmosphere)		<del></del>		Caution/Warning	Out-of-Tol.
2	Humidity				Caution/Warning	Out-of-Tol.
	Acceleration				Caution/Warning	Out-of-Tol.
Service of	Radiation		· · · · · · · · · · · · · · · · · · ·		Caution/Warning	Out-of-Tol.
nesistan pa	Airlock(s)				Warning	Non-programmed opening
	Attitude Control				Caution/Warning	Experiment stability
8	Power - Fuel Cell Press.(s)				Caution/Warning	Out-of-Tol.
	- Fuel Cell Temp.(s) - Voltage, Amperage					
	Shuttle Status	<del></del>			Caution/Warning	Orbiter Condition
*Signal	*Signal hardwired form appropriate sensors				•	
**Audio	**Audio indication/Visual Display					

## SORTIE LAB EXPERIMENTS

# CONTROL/DISPLAY REQUIREMENTS ANALYSIS

### EARTH OBSERVATIONS

REF:

BLUE BOOK, 1/15/71, Vol. IV SORTIE LAB DOC., TASK 4.1.3.2, .3, .4 SKYLAB ODB, Vol. I, Part 2, Rev. A.

### MATERIAL SCIENCES

REF:

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SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	√TS AN	LYSI		SUBSYSTEM/EXP: Earth	Earth Observations
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
82	Metric & Stellar Camera	E0- -12- -15- -65-	7,7	Power Metric camera on/off Met. cam. spectral range adjust Met. cam. frame rate select Stellar camera on/off (4) S.C. (4) spectral range adjust range adjust S.C. frames rate select (4)	Power on M.C. operating status M.C. specral range M.C. frame rate M.C. frames remaining Stellar camera (4) operating status S.C. spectral range(4) S.C. frame rate (4) S.C. frame rate (4)	• 4 stellar cameras within the Metric camera housing. • Some sources say 2 Metric cameras are required.
281	Multispectral Camera	E0-2 - 13 - 14		Power On/off (6) Filter select (6) Exposure time select (1) Frame rate select (1)	Power on Operating status (6) Filter status (6) Exposure time (1) Frames remaining (1) Frame rate (1)	<ul> <li>6 Separate cameras in set.</li> <li>Cameras are syncronized</li> <li>Skylab S-140 applicable</li> </ul>
282	Multispectral TV	ი ი 6 - ი 8 - ი 1 - ი		Power On/off Slitfocus adjust Collimation adjust Line scan speed select (3) Spectral band select (12) Bandwidth select Recorder on/off	Power on Operating status Slit focus Collimation status Scan speed Spectral band (12) Bandwidth Recorder frames remaining Digitizer oper, status	© Camera only; video display not included here.

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SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENT	NTS ANALYSIS	TASI		SUBSYSTEM/EXP: Eart	Earth Observations (Continued)
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
283A	Multispectral Scanner - External	E0-2		Power On/off	Power on Operating status	6 Should be basically similar
283B	Multispectral Scanner - Internal	4-1-4		Mode select Alignment mode select	Operating mode Alignment thermal	See ODB vol. I for S-192 and ESES.
2830	Multispectral Scanner - Electronics	o I		Calibration source	Visible alignment Alignment ready Cal. source	
				select Cal. source intensity	Cal. source intensity	
				Recorder on/off	Recorder status Cryogenics/cooling status	
284A	Passive Microwave Scanner - Antenna	E0-1		Power On/off	Power on Operating status	<ul> <li>Should be equivalent to Skylab S-194, L-Band Radiometer.</li> </ul>
2848	Passive Microwave Scanner - Electronics	1 1 1 1 4 10 A		calloration mode select Cal. time interval	cal. mode Cal. time interval	<pre>may use z radiometers of dit- ferent frequencies.</pre>
		0		Select Recorder on/off CRT on/off Frequency select (?)	Recorder status CRT video Frequency	
285A	Microwave Radar - Antenna	E0-2		Power	Power on	<ul> <li>Limited description available;</li> </ul>
285B	Microwave Radar - Electronics	4 rč		Un/ott Recorder on/off	Uperating status Recorder status	some elements of Skylab S-193 may be applicable.
285C	Microwave Radar - Film Recorder					

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SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	NTS ANA	LYSI		SUBSYSTEM/EXP: Ear	Earth Observations (Continued)
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
9 8 8 8	Multispectral Radiometer	E0-1 -2 -3 -4	·	Power On/off Band select Bandwidth select Look angle select Pointing	Power on Operating status Band Bandwidth Look angle Video and/or cross & along track coordinates.	
287A 287B 287C 287D	Microwaye Radiometer 9M Antenna 9M Antenna Electronics 3M Antenna 3M Antenna Electronics	E0-1		Power 9M on/off 3M on/off 9M band select 3M band select Antennae pointing (2) Beamwidth select?	Power on 9M operating status 3M operating status 9M band 3M band Antennae angles (2) Beamwidths (2)? Sensed temperatures	<ul> <li>Portions of Skylab S-193</li> <li>descriptions may be applicable.</li> </ul>
2 8 8 8 8 8 C C	Scatterometer/Radiometer 44 inch! Antenna Mechanical Scanner Electronics	E0-1 -2 -6		Power On/off scatter. Radiometer on/off S/R scan mode select S/R x-track scan angle select Polarization select Altimeter on/off Altimeter range select	Power on Operating status, scatterometer. Radiometer oper. status S/R scan mode S/R x-track scan angle S/R polorization S/R malfunctions Alt. mode Alt. range	• Portions of Skylab S-193 description is applicable.
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SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENT	E1 E 1	S ANALYSIS		SUBSYSTEM/EXP: Ear†	Earth Observations (Continued)
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
2 8 8 9 8 9 8 9 8 9 8 9 8 9 8 9 9 8 9 9 8 9	Multispectral Spectrometer - Optics	E0-1		Power Spectrometer on/off	Power on Spect, operating	
a n 0	- Fectionics	1		Imaging system on/off Calibration on/off Spectral band select Cooling initiate Telescope alignment	status Imaging (video?) Calibration status Spectral band Temperature Alignment status	• The Image display is probably the same as for the observation telescope (295)
2 90 A	Aeronomy Spectrometer • 1-100 nm	E0-1		Power Interferometer on/off	Power on Interf. Oper. Status	• Also used in space physics • Pointing & video is through
290B 290C	• 0.1 - 1 nm • Electronics		<del></del>	off Calibration on/off Telescope alignment Recorder on/off	status Status Calibration status Alignment status Recorder status	נופ המספראמנוסו ופופטרטשפ (בפס
C0 C0	Spectral Polarimeter	E0-1 -2 -3		Power Polarimeter on/off Telescope alignment Camera actuate Recorder on/off	Power on Operating status Alignment status Camera status Recorder status	<ul> <li>Boresighted with Observation Telescope (295)</li> </ul>
292A 292B	Sferics Detector - Antenna - Flertronics	E0-1		Power On/off Amplifier gain Pass Pand select	Power on Operating status Amplifier gain	
				Beam width select	Beam width	

SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	NTS AN	\LYS!		SUBSYSTEM/EXP: Earth	Earth Observations (Continued)
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
2 8 8 8	Absorption Spectrometer	E0-3 -4		Power On/off Calibration on/o-f Spectral mask select	Power on Operating status Calibration statics Spectral masks in use.	
294A	Optical Radar (Laser Altimeter)	E0-2 -4 -5		Power On/off Coliimation test Camera on/off Tape Recorder on/off	Power on Operating status Collimation status Range measure/video(?) Camera status T.R. status. Frames remaining	Used in conjunction with Metric Camera (280) when photography desired.
20 20 20 20 20	Observation Telescope.	E0-1-2-1-3-3-1-1-5-1-5-1-1-6-1-1-1-1-1-1-1-1-1-1-1-1		Power Magnification select Mirror pointing Camera on/off TV camera on/off Spectrometer align. Other sensor align.	Power on Magnification Gimbal angles Camera status Film remaining TV status TV video display Spect. alignment Sensor alignment Binocular viewer	• Similar in some respects to V/TS of Skylab S-191. • Number of other sensors to be aligned with the Obser. Telescope is unknown.
296	Telescope Computer	E0-1 -2 -3 -4 -5		Power Computer on/off Computer coordinate input select	Power on Comp. Operating status Coordinates	<ul> <li>Probably will use keyboard, but not verifiable.</li> </ul>

		ITHL			
Earth Observation (Continued)	REMARKS	<ul><li>Similar to ERTS</li><li>Primarily automatic</li></ul>	• Direct interface probably required.	• Uses many of displays listed under #299.	<ul> <li>For all sensors that output in analog or digital format.</li> <li>A summary of requirements listed under other equipment numbers.</li> </ul>
SUBSYSTEM/EXP: Eart	DISPLAYS	Power on . Operating status Xmtr. Operating status Malfunctions	Power on Visual Visual Visual Cameras oper. status Cameras frames remaining. Pressure Temperature	Power on Tape Trans. status Projector status Processor status	Power on/ CRT moving displays { CRT scopes Multichannel oscillo- scope Comp. operating status Diff. grating selected
	CONTROLS	Power On/off (receivers) On/off (Transmitters)	Power Microscope pointing Microscope focus Drop insertion Cameras on/off Pressure select Temperature select	Power Tape transport on/off Computer keyboard Film projector on/off	Console Power CRT scopes voltage monitor select Computer input Diffraction gratings
ALYSIS	EXP.				
NTS AN	P/L NO.	E0-3	E0-7	E0-1-1-2-2-1-3-3-3-3-3-3-3-3-3-3-3-3-3-3-3	E0-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1
SORTIE LAB CON <sup>†</sup> TROL/DISPLAY REQUIREMENTS ANA	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	Data Collection System	Cloud Chamber	Data Analysis Equipment - Electronic	Controls and Displays
SORTIE	EQUIP. NO.	297	598	300	299

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SORTIE	SORTIE LAB' CONTROL/DISPLAY REQUIREMENTS ANALYSIS	NTS AN	\LYS19		SUBSYSTEM/EXP: Eart	Earth Observation (Continued)
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
	Continued)			Apertures select Filters select Airlock extenders operate Timing inputs Command inputs Level select Sensor select Auto/manual select Frame rate select Frame select Frame select Frame select Frame select Frame aposition Heater input	Apertures selected Filters selected Airlock extenders position/status Sequences Level status Sensors oper. status Mode Exposure times Frame rates Focus Alignment Antenna orientation EC/LS status Heater status CRT-alphanumeric CRT-alphanumeric CRT-alphanumeric CRT-riggered sweep	
280B	Metric Camera Contamination Cover	E0-1		and the state of t		• No active components, therefore no C/D requirements.
280¢	Stellar Camera Contamination Cover	) 4 rV				
2818	Multispectral Camera Contamination Cover	0				and controls for removing/ replacing the covers on the sensors.
2828	Multispectral TV - Contamination Cover					
291B	Spectral Polimeter Contamination Cover					

SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENT	NTS ANALYSIS	LYSI	S	SUBSYSTEM/EXP: Ea	Earth Observation (Continued)
1	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
	Optical Radar Contamination Cover	E0-1	****			<ul> <li>Same comments as far #2808 thru 2918.</li> </ul>
	Optical Radar Contamination Cover	J 4 17 A				
	Observation Telescope Contamination Cover	Ŷ			p	
	Observation Telescope Contamination Cover					
	Optical Contamination Monitor	E0-1-2-1-4-1-5-1-6-1-5-1-6-1-6-1-6-1-6-1-6-1-6-1-6		·		<ul> <li>Has no power requirements, but may require C/D.</li> <li>No description available.</li> </ul>
	Contamination Monitoring Gage	E0-1 -2 -3 -4 -5				<ul> <li>Has no power requirements, but may require C/D.</li> <li>No description available.</li> </ul>
	Mass Spectrometer Sensor	E0-1 -23 -44 -65				• Has no power requirements, but may require C/D. No description available.

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SORTIE	5		S ANALYSIS		SUBSYSTEM/EXP: Ear	Earth Observation (Continued)
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
9401A	Microwave Radar - Gimbal	E0-2 -4 -5				
9403A	Gimbal - #286/#29l	E0-1				power requirements listed.
V4		40				
9409A	Scatterometer/Radiometer Gimbal	E0-2	**************************************			
9405A	Microwave Radiometer - 9M Antenna Gimbal	E0-1				
9407A	Microwave Radiometer - 3M Antenna Gimbal	E0-1				
9413A	Absorption Spectrometer Gimbal	E0-4				
94018	Microwave Radar - Gimbal Control	E0-2 -3 -4				
94038	Gimbal Control - #286/291	E0-1				
		W41V6				

FOLT EXP CONTROLS  E0-1  E0-1  E0-4  E0-1  On/off  -2  -4  -5 -6  E0-1  Power  -2  0n/off  -3 -4 -5 -6 -6 -6 -6 -7 -9 -9 -9 -9 -9 -9 -9 -9 -9 -9 -9 -9 -9	SORTIE	SORTIE LAB ÇONTROL/DISPLAY REQUIREMENT	11 L. 4	S ANALYSIS		SUBSYSTEM/EXP: Eart	Earth Observation (Continued)
Microwave Radar - 9M Antenna E0-1  Scatterometer/Radiometer E0-2  Gimbal Control  Contamination Monitor E0-1  Contamination Gage Control Unit E0-1  Contamination Gage Control Unit E0-1  Contamination Gage Control Unit E0-1  Mass Spectrometer Package E0-1  -2  -4  -5  -6  Mass Spectrometer Package E0-1  -2  -4  -5  -6  Mass Spectrometer Package E0-1  -2  -4  -5  -6  -6  -6  -7  -7  -7  -7  -7  -7  -7	EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXR	CONTROLS	DISPLAYS	REMARKS
Scatterometer/Radiometer  Gimbal Control  Absorption Spectrometer  Gimbal Control  Contamination Monitor  Contamination Gage Control Unit  Contamination Gage Control Unit  Contamination Gage Control  Mass Spectrometer Package  E0-1  Power  -2  -4  -5  -6  Mass Spectrometer Package  -2  0n/off  -3  -4  -5  -6  Mass Spectrometer Package  -2  -2  -2  -3  -4  -5  -6  Mass Spectrometer Package  -2  -2  -2  -3  -4  -5  -6  -6  Mass Spectrometer Package  -2  -2  -3  -4  -5  -6  -6  -6  -7  -7  -7  -7  -7  -7  -7	94058	t	E0-1				=
Absorption Spectrometer  Gimbal Control  Contamination Monitor  Contamination Gage Control Unit  Contamination Gage Control Unit  Contamination Gage Control  Mass Spectrometer Package  E0-1  On/off  -2  0n/off  -3  -4  -5  -6  Mass Spectrometer Package  E0-1  Power  -5  -6  Mass Spectrometer Package  -2  -2  -3  -4  -5  -6  -6  Mass Spectrometer Package  -2  -2  -3  -4  -5  -6  -6  -6  -7  -7  -7  -7  -7  -7  -7	9409B	Scatterometer/Radiometer Gimbal Control	E0-1 -2 -6				requirements listed.
Contamination Monitor  Control Unit  Contamination Gage Control Unit  Contamination Gage Control Unit  Contamination Gage Control Unit  Ass Spectrometer Package  E0-1  Power  On/off  -2  0n/off  -3  -4  -4  -5  -6  Mass Spectrometer Package  -2  -2  -3 -4  -4  -5 -6	94138	Absorption Spectrometer Gimbal Control	E0-4				
Contamination Gage Control Unit E0-1 Power -2 On/off -3 -4 -4 -5 -6 Mass Spectrometer Package E0-1 Power -2 On/off -3 -4 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5	9102	Contamination Monitor Control Unit	E0-1 -23 -5-1 -5-1		Power On/off	Power on Operating status Contamination data	<ul> <li>No description available; it does have power reg'ts, and data output.</li> </ul>
Mass Spectrometer Package E0-1 Power -2 On/off -3 -4 -4	9104	Contamination Gage Control Unit	E0-1		Power On/off	Power on Operating status Contamination data	• No description available; it does have power req'ts, and data output.
	9106	Mass Spectrometer Package	E0-1 1 2 2 4 4 3 4 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6		Power On/off	Power On Operating status Spectral Data (?)	• No description available; it does have power req'ts, and data output.

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SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	NTS AN	1LYS1		SUBSYSTEM/EXP: Ea	Earth Observations (Continued)
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
9422	Film Storage Cabinet	E0-1 -2 -3 -4 -5				<pre>ø Structural; no C/D req'ts.</pre>
9448	Cryogenic System	E0-2 -3 -5 -5		Power	Power on	• Has no data requirements listed. Should include basic power and status, C/D.
9432	. Elir.	E0-1				• Passive; no C/D req'ts except
9433	Film	E0-2				
9434	Fil	E0-3				
9435	. Elij	E0-4				
9436	m-	E0-5		•		
9437	mli4	E0-6				
	DEPLOYMENT BOOMS					
9417	Passive Microwave Scanner	E0-1	EO-1 thru EO-6	9-0		• C/D requirements, if any, are
9418	Microwave Radar	E0-2,	E0-2, 4,-5			probably included under the primary equipment. No power or data appringments listed
9419	Microwave Radiometer - 9M	E0-1				ממרש ובאתון בוובוורם ווזירבים

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SOBTIE	SOBTIE I AB CONTROL ANISPI AN BEOLIDEMENT	MTC AN	SISVIAMA S		SUBSYSTEM/EXP:	
		יאורט כואוי				Earth Observations (Continued)
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
	DEPLOYMENT BOOMS (Cont'd)					
9420	Microwave Radiometer - 3M	E0-1				
9421	Scatterometer/Radiometer	E0-1	-2,	9 -	er y salvenismismismism	
9447	Multispectral Scanner Contamination Cover	E0-2	۴.	-5, -6	- Am	<ul> <li>Same comments as for #280B thru #291B.</li> </ul>
293B	Absorption Spectrometer Contamination Cover	E0-3	4-		Out of the State o	
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		<u></u>				
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SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	VTS AN	ıLYSI		SUBSYSTEM/EXP: Material	Sciences
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
8 - 0 J	Controlled Atmosphere Chamber	MS-2		Power On/Off Vacuum adjust. Vacuum adjust. Cont. Atmosphere Adjust (8-09) Ion bombardment Ion pump-set Sublimation pump-set I-04 power & on/off I-12 power & on/off	Power on Operating Status Torr level Gas Content (E-01) I.B. status Ion pumb status Sub. pump status I-04 status I-12 status Safety and hazard control status	<ul> <li>Probably also has need for temperature readout, but is not specified. Maybe included in continuous atmosphere B-09.</li> <li>May also be used in other units, or independently.</li> <li>May not be under remote control.</li> </ul>
B-02	Environmental chamber A-Pressure cooling	MS-2 MS-3	۲	Power On/off Temperature adj. Gas content adj. (B-09) Vacuum adj. (B-09) I-01 pwr & on/off I-05 pwr & on/off I-15 pwr & on/off E-03 pwr & on/off	Power on Operating status Temperature Gas content Torr level I-01 status I-04 status I-15 status E-03 status	<ul> <li>May not be under remote control.</li> <li>Some of these equipment can be</li> </ul>
		·		DWA TWA TWA TWA TWA TWA TWA TWA TWA TWA T		used in other units, or dently

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RTIE	Ž	NTS AN	ANALYSIS		SUBSYSTEM/EXP: Material	Sciences (Continued)
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
B-03	Environmental Chamber 8-pressure cooling	MS-2 MS-3 MS-4	1,2	Same requirements as uni imposes no C/D requireme	Same requirements as unit B-02, except that Unit imposes no C/D requirements	I-04 is not used, and therefore
B-05	Biological Enclosure	MS-1	2,_	Power on/off Gas circulation on/off Emergency containment U.V. lamps on/off Phenol/formaldahyde Shower	Power on Operating status Gas circ. system status Safety & hazard control status Pressure level U.V. lamp status Shower status	<ul> <li>UV lamp and disinfectant shower may be activated automatically.</li> <li>Heat sterilazation unit in gas recirculation system may need separate C/D.</li> <li>May not be under remote controlinations.</li> </ul>
8-07	General Purpose Lab Installation	MS-1 MS-2 MS-3 MS-4	- - 2,1,2	Outlets power Gas supply Vacuum pull	Outlets power Gas supply status Vacuum pull status	
B-08	Instrumentation & Control Center	MS-1 MS-2 MS-3	1,2,1 1,2,3 1,2,3	PANELS Inputs to P.C. Computer S-03. Overides to auto. controls. Controls for data recording. On/off for sensors Sensor adjustments	S-Ol operating status Auto control status Displays for outputs of sensors Recorder status Sensor status Data reduction status	• NOTE: This is the basic C/D unit for MS exp'ts.

	7-20-2	SERVICE SERVICE	-	
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SORTIE		LAB CONTROL/DISPLAY REQUIREMENT		S ANALYSIS		SUBSYSTEM/EXP: Materia	Materials Sciences (Continued)	Page 1
EQUIP. NO.		SÜBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS	7 ( 27 Ma) **
					TU & UTR on/off Voice comm. on/off & adjust. Voice recording on/off Safety device & acc. Control syst. on/off	Visual displays, inc. CCTV & VTR Voice comm. status Voice recording status Safety/acc status displays.		Section is such that and property was a section of the
60-	Atmosphere System	re Supply and Control	MS-2 MS-2 MS-4	7,2,3	Power on/off Open/Close gas intake valves. Vacuum pull Gas mixing controls Gas recirculation system on/off/adj.	Power on Operating status Valves status Iorr level Vacuum pull status Gas mixing units status Gas recirculation system status.	• Vacuum not by pump. uses duct/ valves to space.	
8-10	Systems Systems	Systems	MS-1 MS-2 MS-3 MS-4	1,2	On/off Main Pwr Supply connect Pwr. distribution to exp't. units. Voltage conversions Frequency conversions AC/DC Storage Btry connect Emergency shutdown B-10 self test/test	Operating status Main Pwr supply con- nected. Pwr. distribution to exp.t. units - status Voltage, each unit Frequency, each unit AC/DC status, each unit AC/DC status, each unit Btry status. Btry status. Discharge/Recharge Status. Safety/Hazard B-10 test status.	Number of exp't, units which may be connected simultaneously is unknown.	

SORTIE	SORTIE LAB ÇONTROL/DISPLAY REQUIREMENT		S ANALYSIS		SUBSYSTEM/EXP: Materio	Materials Sciences (Continued)
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
I-01	Resistance Heated Furnace 1600 K	MS-2 MS-3	1.2	On/off Temperature adj.	Operating status Temperature	<ul> <li>Some requirements are duplicative of those listed in B-01, B-02, B-03.</li> </ul>
1-04	Heating and Positioning Coils (Set)	MS-2 MS-3	m 04	Power On/off Power level adjust Heating select? Positioning select? Cooling select	Power on Operating status Power level Heating status? Positioning status: Cooling status	• See note in I-01. • May also be used in B-07. • Number of coils which may be in use simultaneously is unknown. • May not require separate action for heating vs. positioning - not known.
I-07	Dispersion Control Systems	MS-3 MS-4	٥-	Power On/off Programming keys for dispersion adj.	Power on Operating status Input status	
I-08	Liquid Sphere Deployment System	MS-3	٧	Sphere detachment actuate Detachment mode adj.	Orifice pressure Sphere detachment status. Detachment mode status operating status.	Supposed to be used only with unit B-06, which is not sched- uled for use on Sortie lab.
I-12	Czochralski Crystal Puller	MS-2		Power On/off Insertion/removal select Rate adjust	Power on Operating status Inseption/removal select status Rate status	<ul><li>C/D req'ts same as for I-15.</li><li>May all be preprogrammed</li></ul>

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SORTII	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	YTS AN	S ANALYSIS		SUBSYSTEM/EXP: Mai	Materials Sciences (Continued)
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
1-13	Susceptor for Silicate Melts	MS-2	_	Power On/off Temperature select	Power on Operating status Temperature (?)	<ul> <li>Temp, display may not be required; uses induction coil for heating.</li> </ul>
I-14	High Temperature Calorimeter	MS-2	~	Power On/off Temperature select (2)	Power on Operating status Temperature (2) Power A integral	<ul> <li>Uses 2 separately controlled</li> <li>cavities.</li> </ul>
1 1 2	Seed Injector	MS-2		On/off (magnets) Insertion/removal select Rate adjust	Operating status Insertion/removal select status Rate status	• C/D req'ts same as for I-12 • May all be preprogrammed.
9	Internal Friction Measuring Device	MS-2	2	Power On/off Oscillation frequency select	Power on On/off Osc. frequency select Status Resonant frequency Power drain Interval temperature	
8 - 18	Continuous Electrophoretic Column Assembly.	MS-1	r-	Power On/off Sample injuection actuate Buffer recovery actuate (I-14) Gas elimination	Power on Operating status Sample injection status Buffer recovery status (I-14) Gas elimination ctatus (I-20)	Multiple columns, Number unknow can be operated independently.  Probably will be under automatic control of D.C. computer (S-01).
				Densitometer actuate (E-13) Interferometer actuate (E-14)	Densitometer Status (E-13) Interferometer Status (E-14)	May be 2 assy's; one in B-05 and one in B-07.

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SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	NTS AN	\LYSI	INS	SUBSYSTEM/EXP: Mate	3SYSTEM/EXP: Materials Sciences (Continued)
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
6 - 1	Buffer Recovery/Waste Disposal System	MS-1	1	Power On/off Recovery initiate Sterilization initiate Carburization initiate	Power on Operating status Recovery status Sterilization status Carburization status	} May be preprogrammed and/or } done manually
1-20	Gas Elimination/Cooling System	MS-1	-	Power On/off Degassing initiate Cooling initiate Recirculation initiate Buffer routing select	Power on Operating status Degassing status Cooling status Buffer temperature Recirculation status Buffer routing	May be preprogrammed and/or done manually.
	Lyophilization Apparatus	MS-1	~	Power On/off Time cycle set Temperature cycle set	Power on Operating status Time cycle Temp. cycle Time remaining Temperature Heat pump status Mechanical stoppering	<ul> <li>Primarily automatic in operation.</li> <li>Will use space vacuum in airlock or thru duct.</li> </ul>
1-22	Molds, Cavities and Crucibles	MS-2 MS-3 MS-4	1,2			• Passive; no C/D req'ts.
I-23	Miscellaneous Internal Attach- ments	MS-2 MS-3	1.2			<ul> <li>Structural; no C/D req'ts.</li> </ul>

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SORTII	SORTIE LAB CONTROL/DISPLAY REQUIREMENT		S ANALYSIS		SUBSYSTEM/EXP: Mater	Materials Sciences (Continued)
EQUIP. NO.	SUBSYSTEM PARAMÉTERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
- - - -	Continuous Atmosphere Analysis Apparatus	MS-2	2° 3°	Power Chromatograph on/off Spectrometer on/off	Power on Chromatograph operating status Spectrometer, operating status Impurity count Impurity type	
E-02	High Temperature Viewing Device	MS-2	м	Power Laser on/off Display adjust. Photograph actuate	Power on Laser oper. status Holographic display	
E-03	Chill System	MS-3	2	Power On/off Cooling/Coding Jet select	Power on Operating status Cooling/Cooling Jet Select Status Cooling Jet Warning Pump status	<ul> <li>Movable unit for multiple location use; may not be susceptible to centralized C/D.</li> <li>May require audible alarm.</li> </ul>
E-04	Motion Picture Camera (16mm)	MS-2 MS-3 MS-4	1,2 1,2	Power On/off Lens changing Focus adjust	Power on Operating status Lens in use Focus in use	<ul> <li>Electrically operated</li> <li>Multiple cameras planned</li> <li>Movable; C/D centralization difficult.</li> </ul>
E-05	TV Camera	MS-1 MS-2 MS-3 MS-4		Power On/off Focus adjust	Power on Operating status Focus Video monitor	<ul><li>All notes same as E-04</li><li>Pan/tilt provisions unknown.</li></ul>
. E-06	Remote Measuring (Mass, Dimensions)	MS-2 MS-3	1,23	Power On/off	Power on Operating status	<ul> <li>Description unavailable;</li> <li>believed to be the device for illuminating/reviewing holo- grams made with E-02.</li> </ul>

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SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	NTS ANALYSIS	\LYSI:		SUBSYSTEM/EXP: Mat	Materials Sciences (Continued)
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
E-07	Mixing Unit - Liquid/Liquid, Liquid/Solid	MS-3 MS-4	2,2	Power Mix mode select Disperion select Chamber temp. select(2) Vibrator on/off (2)	Power on Mode Dispersion Chamber temp. (2) Vibrator oper.	Supposed to be used with units B-06 and/or I-06; neither are scheduled for use in Sortie Lab??
				US transducer on/off (2+) Materials feed on/off (2)	status (2) US trans. oper. status (2+) Materials feed oper. status	
E-08	Mixing Unit - Liquid/Gas	MS-3 MS-4	2	Power Mixing nozzle select Valve pressure select Gas supply on/off Liquid supply on/off Dispersion select Temperature select	Power on Mixing nozzle Mixing nozzle Valve pressure Gas-operating status Liquid-operating status Dispersion Temperature	• Same comment as for E-07 • As described, there are no C/D req'ts. If operation is hostile environment is required remote C/D would have these req'ts.
Б-09	Slip Cast Injection System	MS-3	2	Power On/off Flow control valve set Mixing select	Power on Operating status Flow control valve status Supply container to charging status.	
- - -	Vibrator	MS-13 MS-4	2,_	Power On/off	Power on Operating status	<ul> <li>Mechanical, low-frequency shaker, small.</li> <li>Portable, multipurpose units.</li> <li>Sortie lab may use one, two, or three.</li> <li>Selection is not known.</li> </ul>

SORTII	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	TS ANA	LYSI		SUBSYSTEM/EXP: Ma	Materials Sciences (Continued)
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
- 1 - 0 - 1	Vibrator (Continued)			Power On/off Frequency select Power On/off Frequency select?	Power on Operating status Frequency Power on Operating status Frequency?	<ul> <li>Mechanical, variable lowfrequency shaker, large.</li> <li>Ultrasonic transducer</li> <li>Remote C/D is probably not practical.</li> </ul>
<u>.</u>	Microscope Stage Attachment	MS-2 MS-4	<b>-</b> 01	Power On/off Heating select Cooling select	Power on Operating status Temperature	• Said to be programmable • Used w/microscope in either B-07 or S-04.
т Н	UV Densitometer (micro)	MS-1	_	Power On/off Scan adjust	Power on Operating status Scan mode UV adsorption variation data	<ul> <li>Used only w/unit I-18</li> </ul>
Д	Holographic Interferometer	MS-1		Power On/off (laser) Time Δ select Holocamera initiate Display adjust?	Power on Operating Status, Jaser Time A Holocamera Status	• Laser may be the same as in E-06 and E-02. • Used only w/unit I-18.
- - -	Variable High Frequency Power Unit	MS-2 MS-3	e, c,	Power on/off Frequency select Outlet select for low/high power (2) B-10 connection mode select Power output select	Power on Frequency Outlets/power select B-10 connection mode Power level	<ul> <li>Portable</li> <li>independent; can use both</li> <li>simultaneously</li> </ul>

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SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENT	NTS ANALYSIS	\LYS!!		SUBSYSTEM/EXP: Mat	Materials Sciences (Continued)
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
E-18	External Molds and Containers	MS-3	1,2			Passive; containers for attachment to other containers. No C/D requirements.
E-19	Minor External Components	MS-3 MS-4	2,1			Structural only; no C/D require- ments
S-01	Process Control Computer	MS-2 MS-3	1,3	Power	Power on	<ul> <li>All other C/D requirements are included in B-08.</li> </ul>
S-05	Heat Rejection System	780	78D	Power On/off Active cooling rate select	Power on Operating status Regulator status Radiator status Cooling rate Temperatures	Ø Actual system not defined. C/D reg'ts. shown are estimates of potential reg'ts.
S-03	Cleanup and Refurbishment Equipment	MS-2 MS-3	1,3			<ul> <li>Portable tools; probably non- powered. Assume no C/D req'ts.</li> </ul>
S-04	Materials Analysis Equipment	MS-4	2	Metallograph power Metallograph on/off Saws on/off Polishers on/off X-ray diffraction unit power X-ray diffraction on/off pH meter on/off Zero-G balance on/off (?)	Met. power on Met. operating status Saws operating status Polishers operating status X-ray dift. power on X-ray diff. oper. status pH meter oper. status Zero-G balance operating status (?) Metallographic data	• All are individual units and C/D should be integral w/the unit (except possibly the X-ray diffraction equipment. Will normally be used at B-07, plugging into distributed power.

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SORTIE	SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS	TS ANALY	TASIS		SUBSYSTEM/EXP: Mater	Materials Sciences (Continued)
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS
S-04	Materials Analysis Equipment (Continued)				X-ray diff. data pH data zero-G balance data	
Ю О У	Photographic Processing Lab	- BD	0 8 1	Power Processing tank power Processing tank on/ off Processing tank circulation select Film dryer power Film dryer on/off F.D. temp. select F.D. temp. select F.D. circ. select Printer power Printer power Viewer on/off	Power on Proc. tank power on Status Status Proc. tank circulation rate PT temperature Film dryer power on F.D. operating status F.D. temperature F.D. circulation rate Printer power on Printer power on Printer oper. status Viewer power on Viewer power on Viewer power on	Likely to be a multidiscipline item of equipment.  Could easily be a separate unit of the work area, w/no console C/D req'ts except power. Is not used during exp't operations.
S-06	Open Materials and Fluids Storage	MS-2 MS-3 MS-4	32, 3 1,2			<ul> <li>Storage unit only; imposes no C/D requirements</li> </ul>
S-07	Controlled Atmosphere Fluids Storage	MS-1	1,2	Power On/off Inert gas supply on/ off Gas pressure select Temp. control on/off	Power on Operating status Inert gas oper. status Gas pressure Temp. control oper. status (2)	<ul> <li>May be most feasible to have only the power and caution/warning provisions centralized</li> <li>Used for storage of toxic materials.</li> </ul>

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SORTIE	<b>5</b> ∥		S ANALYSIS	×-~		Materials Sciences (Continued)
EQUIP.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
2-07	Controlled Atmosphere Fluids Storage (Continued)			Atmosphere supply system on/off Atmosphere supply rate/mix select Atmosphere pressure select Access door open/close actuate (4) Airlock evacuate (2) Emergency shutdown and sealing	Atmosphere supply system oper. status rate Mix pressure Access door open/close (4) Ailock evacuation status (2) Material exchange operating status (2) Leaks detected malfunctions warning	Assume inner/outer access doors to each of 2 airlocks for the 2 separate chambers Some type of remote manipulato. will probably be used for material exchange through the airlocks.
S-08	Accident Control System	MS-2 MS-3 3	2,3	Master power/pressure shutdown Alarm resets	Power status Pressure status Audio alarm Video alarm	• All other items are either manually operated or constitute personal protection equipment.



SORTIE LAB CONTROL/DISPLAY

SUBSYSTEM COST SUMMARIES

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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST SUBSYSTEM:	PONENT COST SUBSYS	STEM: DATA MA	NAGEMENT		
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
TV SYSTEM					
1. TV Monitor, 10" CRT		#09	1500in <sup>3</sup> 1000.00	1000.000	2
2. Toggle Switch, 3 Pos. Momentary	<ul><li>Up-on</li><li>Center - not wired</li><li>Down - off</li></ul>	.135	1.63	15.00	2
3. Toggle Switch, 3 Pos. Momentary	• Up - zoom in • Center - not wired • Down - zoom out	.135	1.63	15.00	. 4
4. Toggle Switch, 2 Pos Up Momentary	<ul><li>Up - grid discharge</li><li>Down - not wired</li><li>(if required)</li></ul>	.135	1.63	15.00	7
5. Toggle Switch, 3 Pos. Momentary	<ul><li>Up - pan right</li><li>Center - not wired</li><li>Down - pan left</li></ul>	.135	1.63	15.00	2
6. Toggle Switch, 3 Pos. Momentary	<ul> <li>Up - tilt up</li> <li>Center - not wired</li> <li>Down - tilt down</li> </ul>	.135	1.63	15.00	7
7. Thumb Wheel Pot - Focus	• Focus - center of wheel travel is calibrated with the normal focal noint	.10	1.50	20.00	8
- Brightness	<ul> <li>Brightness - up or right movement causes brighter display</li> </ul>	.10	1.50	20.00	7
- Contrast		.10	1.50	20.00	5

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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST	•	SUBSYSTEM:	EM: ATA MAI	TEM: DATA MANAGEMENT	T (CONTINUED)	NUED)
NOMENCLATURE	REMARKS	)	UNIT WT.	UNIT VOL.		NO. REQD
7. Thumb Wheel Pot (Continued)			.10	1.5	20.00	
- Cross Hair Intensity	<ul> <li>Cross hair intensity- up or right movement causes increase in intensity</li> </ul>	usity- ement in				<b>~</b>
MULTIPURPOSE DISPLAY		·				ang mina Si
1. Toggle Switch, 3 Pos. Momentary	<ul><li>Up - power on</li><li>Center - not wired</li><li>Down - power off</li></ul>		.135	1.63	15.00	
2. Alphanumeric Keyboard	<ul> <li>Allows retrieval of computer stored data using video monitor.</li> </ul>	of data itor.	#09	192in³	1500.00	p
VOICE RECORDING	·					
l. Toggle Switch, 2 Pos.	• Up - power on • Down - power off	••	.135	1.63	15.00	
2. Toggle Switch, 3 Pos. Momentary	<ul><li>Up - fast forward</li><li>Center - not wired</li><li>Down - fast reverse</li></ul>	od ed erse	.135	1.63	15.00	-
3. Toggle Switch, 3 Pos.	<ul><li>Up - record</li><li>Center - not wired</li><li>Down - play</li></ul>	pə.	.135	1.63	15.00	<i></i>
4. Thumb Wheel, Continuous	<ul><li>To right - increases volume</li></ul>	sases	.10	3.5	20.00	·
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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM CON	PLAY SUBSYSTEM COMPONENT COST SUBSYSTEM: DATA MANAGEMENT (CONTINUED)	STEM: DATA MA	ANAGEMEN	T (CONTI	NUED)
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT	NO. REQD
5. Fixed Scale, Movable Pointer Analog Meter	<ul> <li>Upward or right move- ment indicates in- crease in volume, scale is TBD.</li> </ul>	. 65	16.50	150.00	<b>-</b> -
6. Digital Readout, 5 Digits	<ul> <li>Indicates recording time remaining.</li> </ul>	.75	21in³	240.00	<del></del>
7. Digital readout, 5 Digits	<ul> <li>Indicates location on tape in units of feet.</li> </ul>	.75	21in³	240.00	e
DATA RECORDING, ANALOG					
1. Toggle Switch, 2 Pos.	<ul><li>Up - power on</li><li>Down - power off</li></ul>	.135	1.63	15.00	<b>,-</b>
2. Toggle Switch, 3 Pos. Momentary	<ul><li>Up - fast forward</li><li>Center - not wired</li><li>Down - fast reverse</li></ul>	.135	1.63	15.00	·
3. Toggle Switch, 3 Pos.	• Up - record • Center - not wired • Down - play	.135	1.63	15.00	<b>,</b>
4. Rotary Switch, 5 Pos.	<ul> <li>Five record rates - will be available.</li> </ul>	.3.	1.77	16.00	
5. Digital readout, 5 Digits	• Indicates location on tape in units of feet.	.75	2lin³	240.00	<b>-</b>
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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST	UBSYSTEM COMPONENT COST SUBSYSTEM: DATA MANAGEMENT	STEM: ATA MANA	GEMENT	CONTINUED	ED)
NOMENCLATURE	REMARKS	CNI WH	UNIT VOL.	UNIT	NO. REQD
DATA RECORDING, DIGITAL					
1. Toggle Switch, 2 Pos.	<ul><li>Up - power on</li><li>Down - power off</li></ul>	.135	1.63	15.00	prove the second
2. Toggle Switch, 3 Pos. Momentary	<ul><li>Up - fast forward</li><li>Center - not wired</li><li>Down - fast reverse</li></ul>	.135	1.63	15.00	
3. Toggle Switch, 3 Pos.	<ul><li>Up - record</li><li>Center - not wired</li><li>Down - play</li></ul>	.135	1.63	15.00	
4. Rotary Switch, 5 Pos.	<ul><li>Five record rates will be available.</li></ul>		1.77	16.00	
5. Digital readout, 5 Digits	<ul> <li>Indicates location on tape in units of feet.</li> </ul>	.75	21in³	240.00	
VIDEO RECORDER					
1. Toggle Switch, 2 Pos.	• Up - power on • Down - power off	.135	1.63	15.00	
2. Toggle Switch, 3 Pos. Momentary	• Up - fast forward • Center - not wired • Down - fast reverse	.135	1.63	15.00	1
3. Rotary Switch, 5 Pos.	<ul><li>Five record rates will be available.</li></ul>	<u>ن</u> ع.	1.77	16.00	
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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT	ORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST SUBSYSTEM:  DATA MANAGEMENT ( CON-	STEM: A MANAGEMENT	MENT (	CONTINUED	D)	
NOMENCLATURE		UNIT WT.	UNIT VOL.	UNIT	NO. REQD	
Digital Readout, 5 Digits	<ul> <li>Indicates location on tape in units of feet.</li> </ul>	.75	21in³	240.00	<b>-</b>	HTGIXI
l. Toggle Switch, 3 Pos. Momentary	• Up - provides command to slew the tens digit of the event time hrs. display. • Center - not wired • Down - provides command to slew the units digit of the event time hrs. display.	.135	1.65	15.00	-	
Switch, 3 Pos. Momentary	• Up - provides command to slew the tens digit of the event time min. display. • Center - not wired • Down - provides command to slew the units digit of the event time min. display.	.135	1.65	15.00		

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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST	SUE	SSYSTEM: DATA MANAGEMENT	MENT ( C	CONTINUED	( (
NOMENCLATURE	S	UNIT WT.	UNIT VOL.	UNIT	NO. REQD
Toggle Switch, 3 Pos. Momentary	• Up - provides command	.135	1.65	15.00	
	to slew the tens digit of the event time sec. display. Center - not wired Down - provides command to slew the units digit of the event time sec. display.				
Toggle Switch, 2 Pos.	<ul><li>Up - tone enable</li><li>Down - tone inhibit</li></ul>	.135	1.65	15.00	
Toggle Switch, 2 Pos. Momentary	<ul><li>Up - start timer</li><li>Center - not wired</li><li>Down - stop timer</li></ul>	.135	1.65	15.00	
Digital Readout, 6 Digits	• First two digits - hours. • Second two digits - minutes. • Last two digits - seconds.	06	24in³	290.00	-
	TOTAL:	191.53	191.53 3403.70 5788.00	5788.00	

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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: COMMUNICATIONS SYSTEM	)MMUNICA	TIONS SN	STEM
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT	NO. REQD
VOICE TRANSMITTERS					
- Toggle Switch, 2 Pos.	• Up - ON	.135	1.63	15.00	_
- Rotary Dot, continuous	• Down - OFF	.100	1.50	200	<b>,</b>
- Press-to-Talk-Switch	<ul> <li>Clockwise - Increase volume</li> </ul>	e .850			<b>-</b> -
- Intercom & Speaker System	<ul><li>Select - Voice transmit</li></ul>	-18	320	009	•
	TOTAL:	18.485	. 323.13	815.00	4

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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST SUBSYSTEM:	PONENT COST SUBSYS		POWER SYSTEM	YSTEM	
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT	NO. REQD
FUEL CELL INPUT, OUTPUT, INTERNAL TEMP.					
1. Rotary Switch, 12 Positions	• Position 1 $-0_2$ input temp.	.33	1.77	16.00	4
	<ul> <li>Position 2</li> <li>H<sub>2</sub> input temp.</li> </ul>				
	<ul> <li>Position 3</li> <li>H<sub>2</sub>O output temp.</li> </ul>				
	<ul><li>Position 4</li><li>internal temp.</li></ul>				
2. Dual Scale Analog Meter	• Monitor temp. pres.	1.30	33.0	300.00	<b></b>
3. Toggle Switch, 2 Positions	• Up - On Down - Off	.135	1.65	15.00	4
FUEL CELL INPUT PRESSURES	•				
1. Rotary Switch, 12 Positions	• Position 5 $-0_2$ input pres.	تع	1.77	16.00	;
	• Position 6 - H <sub>2</sub> input pres.				
-	•				

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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST	EM COMPONENT COST SUBSYSTEM: POWER SYSTEM (Cont'd)	STEM:	POWER SYSTEM (Cont'd)	STEM (CO	nt'd)
NOMENCLATURE		UNIT WT.	UNIT VOL.	UNIT	NO. REQD
FUEL CELL FLOW RATES					
1. Rotary Switch, 12 Positions	• Position 1 - 0 <sub>2</sub> flow	.31	1.77	16.00	
	<ul><li>Position 2</li><li>H<sub>2</sub> flow</li></ul>				
	<ul><li>Position 3</li><li>H<sub>2</sub>0 flow</li></ul>				2. A44
2. Single Scale Analogue Meter	<ul><li>Monitors - flow rates</li></ul>	.65	16.5	150.00	
FUEL CELL 02 HEATER					
l. Toggle Switch, 3 Positions	• Up - ON, Primary Power	.135	1.65	15.00	<b></b>
	• Center - OFF				
	• Down - ON, Secondary Power				
2. Mechanical Flag, 3 Positions	• Bp - Heater OFF	٥٢.	8.5	75.00	<u></u>
	<ul> <li>White - Heater command ON, operating temp. not reached.</li> </ul>				
	<ul><li>Gray - Heater at oper ating temp.</li></ul>				
A PARTY CONTRACTOR OF THE PARTY	WATER COME TO A STANDARD CO. COME AND MANAGEMENT OF A PROPERTY OF A STANDARD CO.	-	7		1.00 mm

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST   SUBSYSTEM:	APONENT COST SUBSYS	STEM:	POWER	SYSTEM (	(Cont.)
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT	NO. REQD
3. Alert Light	<ul> <li>Light should illumin- ate when heater fails ON or OFF.</li> </ul>	.03	10.	5.00	-
FUEL CELL H2 HEATER					
l. Toggle Switch, 3 Position	<ul> <li>Up - ON, Primary Power</li> <li>Center - OFF.</li> <li>Down - ON Secondary Power</li> </ul>	.135	1.65	15.00	<b>-</b>
2. Mechanical Flag, 3 Position	• Bp - Heater OFF • White - Heater com- mand on, operating temp. not reached. • Gray - Heater at operating temp.	01.	လ က	75.00	-
3. Alert Light	<ul> <li>Light should illumi- nate when heater fails ON or OFF.</li> </ul>	.03	6.	5.00	<b>-</b>
FUEL CELL 02 INLET VALVE					
1. Toggle Switch, 2 Positions	<ul><li>Up - OPEN</li><li>Down - CLOSED</li></ul>	.135	1.65	15.00	<b></b>
2. Mechanical Flag, 3 Positions	<ul> <li>Bp - Valve CLOSED</li> <li>White - Valve in transition.</li> <li>Gray - Valve in OPEN</li> </ul>	.10	8 2	75.00	-

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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM:	rem:	POWER S'	SYSTEM (Cont.	Cont.)
NOMENCLATURE	REMARKS		UNIT WT.	UNIT VOL.	UNIT	NO. REQD
FUEL CELL H2 INLET VALVE						
l. Toggle Switch, 2 Positions	• Up - OPEN • Down - CLOSED	-	.135	1.65	15.00	,
2. Mechanical Flag, 3 Positions	<ul><li>Bp - Valve CLOSED</li><li>White - Valve in</li><li>Valve in OPEN</li></ul>	trans.	.10	8 .5	75.00	<b>,-</b>
FUEL CELL PURGE						
l. Toggle Switch, 2 Positions	<ul> <li>Up - OPEN O2 and H2</li> <li>cell outlet valves.</li> <li>Down - CLOSE O2 and H2 cell outlet valves</li> </ul>	<del></del>	.135	1.65	15.00	_
2. Mechanical Flag, 3 Positions	<ul> <li>Pb - valve OPEN</li> <li>White - valve in transition</li> <li>Gray - valve CLOSED</li> </ul>	SED	.10	8.5	75.00	2
	·					
	•					•



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST	PONENT COST SUBSYSTEM:	STEM:	POWER S	POWER SYSTEM (Cont'd)	ont'd)
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT	NO. REQD
FUEL CELL OUTPUT VOLTAGE AND POWER, (28 vdc. 110 vac BUSES)					
1. Analog Meter, Dual Scale, Moving Pointer	<ul> <li>Verticle, linear meter should have range of 0-150v.</li> </ul>	1.30	33.0	300.00	
2. Rotary Switch, 12 Positions	<ul> <li>Permits display of vdc and 110 vac buses</li> </ul>	.33	1.77	16.00	
	TOTAL	7.23	160.76	1441.00	26

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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST	SUBSYSTEM COMPONENT COST   SUBSYSTEM: LIGHTING SYSTEM	/STEM: L	IGHTING	SYSTEM	
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
CABIN LIGHTING					
<pre>1. Toggle Switch, 3 Positions</pre>	• Up - VARIABLE • Center - OFF • Down - FIXED	.135	1.65	15.00	<b>~</b>
2. Rotary Switch, Continuous		٤.	1.77	16.00	
EXTERNAL LIGHTING					
1. Toggle Switch, 2 Positions	• Up - ON ` • Down - OFF	.135	1.65	15.00	_
PANEL LIGHTING					
1. Toggle Switch, 3 Positions	<ul><li>Up - VARIABLE</li><li>Center - OFF</li><li>Down - FIXED</li></ul>	. 135	1.65	15.00	
2. Rotary Switch, Continuous	• Clockwise - BRIGHTER (when toggle switch is in VARIABLE position)	<u>د</u> .	1.77	16.00	_

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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST	SUBSYSTEM COMPONENT COST SUBSYSTEM:	SYSTEM:	LIGHTING	SYSTEM (Cont.	(Cont.)
1	REMARKS	UNIT WT.	UNIT VOL.	UNIT	NO. REQD
•					
DISPLAY LIGHTING					
l. Toggle Switch, 3 Positions	<ul><li>Up - VARIABLE</li></ul>	.135	1.65	15.00	<i>_</i>
	• Center - OFF				
	• Down - FIXED				
2. Rotary Switch, Continuous	• Clockwise - BRIGHTER	.3]	1.77	16.00	<b>–</b>
	when toggle switch is in VARIABLE posi-				
	tion)	<del></del>			
LIGHTING TEST					
1. Rotary Switch, 5 Positions	<ul><li>Positions: (1) OFF,</li><li>(2) ATTITUDE, (3) C&amp;W,</li></ul>		1.77	16.00	<b></b> -
	(4) STATUS, (5)NUMER	SIC SIC			
2. Toggle Switch, 2 Positions (One Position Momentary)	<ul><li>Up - MOMENTARY Illuminate light</li></ul>	.135	1.65	15.00	<b></b>
	category selected o rotary switch	uo			
	Down - NOT WIRED	······································			
		<del></del>			
	TOTAL:	1,92	15.33	139,00	σ
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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL	PONENT COST SUBSYS EXP. AT	S <b>TEM:</b> TTITUDE/	KSTEM: ATTITUDE/STABILITY CONTROL	ΓY CONTR	or O
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT	NO. REQD
EXP. ATTITUDE MONITORING					
<ul> <li>Analog Meter, Dual Scale</li> </ul>	<ul> <li>Display - CMG: wheel speed temp. amps.</li> </ul>	7.3	33.0	300.00	<b>-</b>
	• Momentum - Hx, Hy, Hz, Hz, Hz,				
<ul><li>Rotary Switch, 12 Positions</li></ul>	<ul> <li>Select - CMG: wheel speed temp. amps.</li> </ul>	<u>.</u> اع	1.77	16.00	_
	<ul><li>Momentum - Hx, Hy, Hz, Ht.</li></ul>		•		
<ul><li>Digital Counter, 4 Digits</li></ul>	• Display - Vehicle Att. pitch, yaw and roll	.75	21.00	240.00	
	<ul> <li>Star Tracker pitch &amp; yaw.</li> </ul>				
	• Orbital plane error.				
	• Beta Angle - AB.				
• Toggle Switch, 3 pos momentary	• Up - star tracker enable				
-	• Center - not wired				
en de la constant de la compansión de la compansión de la compansión de la compansión de la compansión de la c	<ul><li>Down - star tracker inhibit</li></ul>	·			

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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COM	UBSYSTEM COMPONENT COST   SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL	YSTEM: ATTITUDE/STABILITY CONTROL	STABILIT	Y CONTRO	)L
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT	NO. REQD
EXP. ATTITUDE MONITORING (Continued)					
<ul> <li>Toggle Switch, 3 pos momentary</li> </ul>	• Up - shutter open	.135	1.63	15.00	_
	• Center - not wired				
5	• Down - Shutter closed				
<ul> <li>Toggle Switch, 3 pos momentary</li> </ul>	• Up - Acq. Auto	.135	1.63	15.00	<del></del>
	• Center - not wired				
	Down - manual				
• Toggle Switch, 3 pos momentary	<ul> <li>Up - momentum dump enable</li> </ul>	.135	1.63	15.00	
	• Center - not wired				
	• Down - inhibit				
<ul> <li>Toggle Switch, 3 pos momentary</li> </ul>	• Up - cage gimbles	.135	1.63	15.00	
·	• Center - not wired				
•	• Down - release				
• Toggle Switch, 2 pos	• Up - Exp. Ptg.	.135	1.63	15.00	<b></b>
	• Down - off				
	•				
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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM CON	SUBSYSTEM COMPONENT COST EXP. ATTITUDE/STABILITY CONTROL	UBSYST XP. ATTI	EM: rTUDE/s	TABILIT	Y CONTR	)L
NOMENCLATURE	REMARKS		UNIT WT.	UNIT VOL.	UNIT	NO. REQD
ATTITUDE CONTROL SYSTEM						
	• Pitch, yaw & roll.	ا.(اه				
	<ul> <li>Pitch &amp; yaw, manual control of star tracker</li> </ul>	anual tar				
<ul><li>Toggle Switch, 3 pos. (mom-mom)</li></ul>	• Enable/Inhibit		.135	1.63	15.00	_
• Digital Counter	<ul> <li>Display - event time lapsed</li> </ul>		.75	21.00	240.00	<b></b> -
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SORTIE LAB CONTROL/DISPLAY S	SU	E I	STABILITY CONTROL	Y CONTR(	10
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT	NO. REQD
EXP. ATTITUDE MONITORING (Continued)					
• Rotary Switch, 12 pos.	• Select Vehicle Att. pitch, Yaw and roll.	.31	1.77	16.00	-
	<ul><li>Star Tracker pitch and yaw.</li></ul>				
	• Orbital plane error.				
	• Beta Angle - 🗚				
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)[	NO. REQD						per						, 14 m
Y CONTRO	UNIT		150.00		16.00		21.00 240.00						-
SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL	UNIT VOL.		16.50		1.77		21.00				7:		
TEM: TITUDE/S	UNIT WT.		.65		<u>.</u> ت		.75						
-	REMARKS		<ul> <li>Display - CMG: wheel speed temp. amps.</li> </ul>	<ul><li>Momentum - Hx, Hy, Hz, Ht.</li></ul>	<ul> <li>Select -         CMG: wheel speed         temp. amps.</li> </ul>	<ul><li>Momentum - Hx, Hy, Hz, Ht.</li></ul>	• Display - Vehicle Att. pitch, yaw and roll.	<ul> <li>Star Tracker pitch and yaw</li> </ul>	• Orbital plane error	• Beta Angle - Δβ			•
AY SUBSY	NOMENCLATURE	EXP. ATTITUDE MONITORING	<ul> <li>Analog Meter, Dual Scale</li> </ul>	÷	<ul> <li>Rotary Switch, 12 pos.</li> </ul>		• Digital Counter, 4 digit				- ,		-

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UNIT   UNIT   UNIT   UNIT     • Up - solar inertial   .135   1.63   15.00     • Up - attitude hold   .135   1.63   15.00     • Up - Acq. S. S.   .135   1.63   15.00     • Up - Acq. S. S.   .135   1.63   15.00     • Up - Comp. Time   .135   1.63   15.00     • Down - inhibit   .135   .163	SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		STEM: TITUDE/	SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL	Y CONTRO	)L
• Up - solar inertial .135 1.63 • Down - ZLV • Up - attitude hold .135 1.63 • Up - Acq. S. S135 1.63 • Up - Comp. Time .135 1.63 • Down - inhibit		1	UNIT WT.	UNIT VOL.	UNIT	NO. REQD
• Up - solar inertial .135 1.63 • Down - ZLV • Up - attitude hold .135 1.63 • Down - Orbiter  • Up - Acq. S. S135 1.63 • Down - Sun  • Up - Comp. Time .135 1.63 • Down - inhibit	EXP. ATTITUDE MONITORING (Continued)					
• Down - ZLV • Up - attitude hold .135 1.63 • Down - Orbiter  • Down - Orbiter  • Down - Sun  • Down - Sun  • Up - Comp. Time .135 1.63  • Down - inhibit	<ul><li>Toggle switch, 2 pos</li></ul>	• Up - solar inertial	.135	1.63	15.00	~
• Up - attitude hold .135 1.63 • Down - Orbiter  • Up - Acq. S. S135 1.63 • Down - sun  • Up - Comp. Time .135 1.63 • Down - inhibit		• Down - ZLV				<u>.</u>
• Down - Orbiter  • Up - Acq. S. S	<ul><li>Toggle switch, 2 pos</li></ul>	• Up - attitude hold	.135	1.63	15.00	<b>,</b>
<ul> <li>bown - Sun</li> <li>Down - Sun</li> <li>Up - Comp. Time</li> <li>Up - Comp. Time</li> <li>Down - inhibit</li> </ul>		• Down - Orbiter				
pos  • Up - Comp. Time  • Up - Comp. Time  • Down - inhibit	8	• Up - Acq. S. S.	.135	1.63	15.00	-
• Up - Comp. Time .135 1.63 enable • Down - inhibit		● Down - sun	-			
• Down - inhibit	• Toggle switch, 2 pos	<ul> <li>Up - Comp. Time enable</li> </ul>	.135	1.63	15.00	<b></b>
		Down - inhibit		y. ¥		
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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST   SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL	APONENT COST EXP.	YSTEM: ATTITUDE/	STABILITY CONTROL	Y CONTRO	)[
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
• Rotary Switch, 12 Positions	<ul><li>Select - Vehicle Att. pitch, yaw and roll</li></ul>	.31	1.77	16.00	-
·	<ul> <li>Star Tracker pitch &amp; yaw.</li> </ul>				
	• Orbital plane error.				
	• Beta angle - Δβ.	<del></del>			**************************************
ATTITUDE CONTROL SYSTEM					
<ul><li>Hand Controller, 3 Axis</li></ul>	<ul> <li>Pitch, yaw, &amp; roll.</li> </ul>	.95	60.00	2,000	
		· · · · · · · · · · · · · · · · · · ·			
<ul> <li>Toggle Switch, 3 Positions (mom-mom)</li> </ul>	• Enable/Inhibit	.135	1.63	15.00	
<ul> <li>Toggle Switch, 3 Positions (mom-mom)</li> </ul>	• Up - star tracker				-
	• Down - Exp. Pointing	ð			
• Toggle Switch, 3 Positions (mom-mom)	<ul> <li>Up - star tracker auto</li> </ul>	.135	1.63	15.00	-
	Down - star tracker     manual				
	. TOTAL	24.26	198.94	4,749	23

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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST	COMPONENT COST SUBSYSTEM: ENVIR. CONTROL/LIFE SUPPORT	STEM: . CONTRO	FEM: CONTROL/LIFE S	SUPPORT	
			UNIT VOL.	UNIT	NO. REQD
•					
<ul><li>Toggle Switch, 2 Positions</li></ul>	<ul> <li>Orbiter/Sortie Lab press. equalization on-off.</li> </ul>	.135	1.65	15.00	
<ul><li>Toggle Switch, 2 Positions</li></ul>	● Fan, on-off.	.135	1.65	15.00	4
<ul><li>Toggle Switch, 2 Positions</li></ul>	• Collant, on-off	.135	1.65	15.00	p
<ul><li>Toggle Switch, 2 Positions</li></ul>	<ul><li>Heater, on-off</li></ul>	.135	1.65	15.00	
<ul><li>Toggle Switch, 2 Positions</li></ul>	• Humidity control	.135	1.65	15.00	\$ 10 kg
<ul><li>Toggle Switch, 2 Positions</li></ul>	• $0_2/N_2$ part. press. control, on-off.	.135	1.65	15.00	8
<ul><li>Toggle Switch, 2 Positions</li></ul>	<ul> <li>Cabin press. relief open-close.</li> </ul>	.135	1.65	15.00	,
<ul><li>Toggle Switch, 2 Positions</li></ul>	<ul> <li>Cabin temp. bypass open-close</li> </ul>	.135	1.65	15.00	g
<ul> <li>Toggle Switch, 2 Positions</li> </ul>	• Collant pump, on-off.	.135	1.65	15.00	
• Toggle Switch, 2 Positions	<ul><li>Bypass, on-off.</li></ul>	.135	1.65	15.00	
<ul> <li>Toggle Switch, 2 Positions</li> </ul>	<ul> <li>Pump power on-off.</li> </ul>	.135	1.65	15.00	
• Toggle Switch, 2 Positions	<ul><li>Flow rate control, on-off.</li></ul>	.135	1.65	15.00	
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SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST   SUBSYSTEM: ENVIR. CONTROL/LIFE SUPPORT (Cont.)	PONENT COST SU	SUBSYSTEM: ENVIR. CONTRO	TEM: CONTROL/LIFE S	SUPPORT (	(Cont.)
NOMENCLATURE			UNIT VOL.	UNIT	NO. REQD
•					
• Display, Dual Scale Meter	• Temp. in/out and payload temp.	1.3	33.0	300.00	_
• Toggle Switch, 2 Positions	• Temp. in/out.	.135	1.65	15.00	r
• Rotary Switch, 12 Positions	• Payload temp. sel.	.33	1.77	16.00	
• Display, Dual Scale Meter	• Temp. °F/Re. Hum.	1.3	33.0	300.00	_
• Display, Dual Scale Meter	• PP of 0 <sub>2</sub> /N <sub>2</sub>		33.0	300.00	,
• Toggle Switch, 2 Positions	<ul><li>Radiator, deploy/ retract.</li></ul>	.135	1.65	15.00	
•					
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		·· <del>·</del> ·································			- 5a 5 8 8 1
	TOTAL:	7.28	132.12	1186.00	22
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SORTIE LAB CONTROL/DISPLAY	LAY SUBSYSTEM CON	R : 1	SUBSYS CAUTION	TEM: AND WAF	SNING		
NOMENCI		REMARKS		UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
• Status Lights - 101 Ba	Bank			1.0	17.40	150.00	2
					•		
		101	TOTAL:	2.0	34.80	300.00	2